Improving
ENERGY USE IN CANADA

Report to Parliament Under the Energy Efficiency Act

1996 1997

Natural Resources Canada
Ressources naturelles Canada

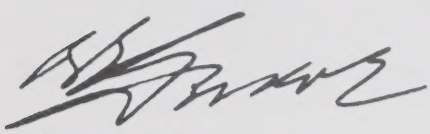
Canada

His Excellency the Right Honourable Roméo LeBlanc
P.C.,C.C.,C.M.M.,C.D.,Q.C.
Governor General of Canada and Commander-in-Chief

Your Excellency:

I have the honour to present the *Report to Parliament Under the Energy Efficiency Act* for the fiscal year ending March 31, 1997, in accordance with section 36 of the act.

Respectfully submitted,



Ralph Goodale
Minister of Natural Resources

Published by the authority of the Minister of Natural Resources
Government of Canada

Editing:
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Energy Publications
Office of Energy Efficiency
Natural Resources Canada
c/o Canada Communication Group
Ottawa, ON K1A 0S9
Fax: (819) 994-1498

Cat. No. M92-73/1997E
ISBN 0-662-83529-8

Aussi publié en français sous le titre de :
Améliorer la consommation énergétique au Canada - Rapport au Parlement en vertu de la Loi sur l'efficacité énergétique, 1996-1997

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MINISTER'S FOREWORD

I am pleased to present to Parliament the fifth report under the *Energy Efficiency Act*. This report provides Canadians with information about the energy efficiency and alternative energy programs administered by Natural Resources Canada (NRCan), describes their progress from 1990 to 1996 and reports on specific achievements during 1996–1997.

NRCan's analysis indicates that more Canadians are using energy more efficiently. Canadians at home and in their businesses used 3.2 percent less energy in 1996 than they would have without the energy efficiency measures taken since 1990. NRCan's energy efficiency initiatives helped to create this improvement. We have made some good progress through a combination of legislation, regulations, incentives, information, peer group pressure and new technology. Industrial energy efficiency is improving, as is the cost-effectiveness and performance of renewable energy. The Government of Canada promotes the use of renewable energy sources and new energy technologies. My department, working with other governments and the private sector, has been investing in research and development, and assisting in the deployment of new technologies. These new technologies will benefit both Canadian energy suppliers and users.

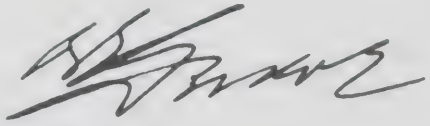
This Report to Parliament also outlines the progress in developing indicators to assess the effectiveness of the energy efficiency programs. Some indicators are the value of contracting activity by energy service companies and the efficiency of equipment for residential and commercial sectors. My department will continue to develop and refine both the data and analysis of energy efficiency trends in Canada. I will include the results in future Reports to Parliament.

Energy efficiency and alternative sources of energy have received increased attention since December 1997, when Canada committed to reducing our greenhouse gas emissions by 6 percent from their 1990 levels by the period spanning 2008 and 2012. The Protocol agreed to by more than 150 countries at the Kyoto climate change conference has instilled in us a sense of urgency and has given a sharper focus to all activities related to sustainable development in energy.

This target will be a significant challenge for all Canadians. Using less energy and switching to energy sources that emit less carbon are two of the most effective ways of reducing greenhouse gas emissions. Our efforts have to be directed at encouraging energy efficiency, developing alternative energy markets and focusing research and development resources on providing technology solutions to this global challenge.

As a direct response to our Kyoto commitment, we established the Office of Energy Efficiency (OEE) to provide all levels of government, industry and consumers with a "one-stop shop" for energy efficiency advice, programs and support. Under the umbrella of the OEE, NRCan is raising the profile of energy efficiency in Canada, increasing program recognition and broadening participation.

I believe that Canadians are up to the challenge that climate change requires of them. The federal government will continue to provide the leadership and the tools to help them meet this challenge. Today's energy needs must be addressed without compromising either the environment or the ability of future generations to meet their requirements. This condition is the essence of Canada's strategy for sustainable development in energy.



Ralph Goodale

EXECUTIVE SUMMARY

This fifth report to Parliament under the *Energy Efficiency Act* reviews the progress of the energy efficiency and alternative energy (EAE) initiatives of Natural Resources Canada (NRCan) during the 1996–1997 fiscal year. These initiatives are critical to the National Action Program on Climate Change, which sets out the strategic directions Canada will follow to limit greenhouse gas emissions.

NRCan's EAE initiatives are designed to reduce carbon dioxide (CO_2) emissions by lessening the amount of energy required for a given level of service (energy efficiency), or by replacing some carbon-intensive energy sources with energy generated from sources that produce fewer or no CO_2 emissions, such as wind power or small hydro power (alternative energy). In 1996–1997, NRCan's EAE initiatives used four policy instruments to pursue these objectives:

- regulation;
- information;
- voluntary action; and
- science and technology.

This report contains many more quantified indicators of the progress of NRCan's program initiatives than have previous reports under the Act. The Energy Efficiency Branch (now the Office of Energy Efficiency) of NRCan developed these indicators to better show how NRCan's EAE initiatives affect energy use. It is not always possible to establish a clear link between EAE initiatives and changes in energy use; more work needs to be done in this area. Future reports will further refine these indicators.

This report deals with secondary energy use, which is the consumption of energy in the residential, agricultural, commercial and institutional, industrial, and transportation sectors. (It does not address the consumption of energy to produce and deliver energy to the marketplace, and to convert energy from one form to another.) The industrial sector was responsible for 38 percent of secondary energy demand in 1996, followed by the transportation sector (27 percent), and the residential and commercial sectors (19 percent and 13 percent respectively). More than $75 billion, or 10 percent of the country's gross domestic product, was spent on secondary energy in Canada during 1996.

Secondary energy use—excluding emissions produced indirectly by power generators to meet end-use demand for electricity—produces about 64 percent of total CO_2 emissions in Canada. Between 1990 and 1996, secondary energy use increased by 11.4 percent. However, related CO_2 emissions increased by only 7.2 percent, as secondary energy users and the electrical generation industry switched to less carbon-intensive fuels. Improvements in energy intensity (a measure of energy efficiency) reduced the increase in secondary energy use by 3.6 percent between 1990 and 1996. This improvement in energy intensity represents a saving for Canada of $4 billion in expenditures on energy each year.

This report includes introductory chapters on the policy context of energy efficiency and alternative energy programs, a description of the Act and Regulations, and the connection between energy use and greenhouse gas emissions. These are followed by chapters on each energy use sector, with descriptions of initiatives, progress indicators and achievements. The report concludes with chapters on renewable and district energy, and NRCan's intergovernmental cooperation in EAE.

Quantifiable indicators have been used where possible. Between 1990 and 1996, significant progress has been achieved, as indicated in Table 1.

Table 1
Programs and Progress Indicators

Program	Progress Indicators
Energy Efficiency Regulations	• Residential sector: energy efficiency gains of 36 percent for refrigerators since 1990 • Commercial sector: lighting regulations estimated to save 10 petajoules of electricity by 2000 • Industrial sector: changes to electric motor regulations estimated to save 16.3 petajoules by 2010
Model National Energy Codes for buildings and houses	• Approved by Canadian Commission on Building and Fire Codes in March 1997. Adoption could reduce energy use in newly constructed buildings by 15 to 30 percent.
R-2000 HOME Program	• Increased adoption of R-2000 practices in mainstream construction. Forty percent decrease in the average number of air changes per hour (an indicator of construction quality) in all newly constructed houses since the program began.
Home Energy Retrofit Initiative	• Placement of Reno$ense Planning Centres in 266 Home Hardware stores across Canada • Development of a single-number energy efficiency rating for residential windows
C-2000 Program	• Completion of two buildings that meet C-2000 standards (they consume about 55 percent less energy than conventional buildings)
Energy Innovators Initiative	• Registration of 376 organizations in the program; 42 percent of them have implemented energy-saving measures.
Federal Buildings Initiative	• Total investment commitments in FBI projects of $125 million, with estimated annual energy savings of $20 million • Increase in the value of contracts awarded to qualified energy service companies from $50 million to $300 million between 1991 and 1996 • Undertaking by the Government of New Brunswick of a Provincial Buildings Initiative modelled on the FBI
Federal Industrial Boiler Program	• Savings of 80 terajoules of energy in 1996, the equivalent of the annual energy use of 30 000 refrigerators
Industrial Energy Efficiency Initiative	• Recruitment of 238 industrial companies—representing 74 percent of industrial energy use—as Industrial Energy Innovators • Commitment by 20 industrial task forces, representing 90 percent of total industrial energy demand, to energy efficiency improvement targets by 2000—most exceeded their targets between 1990 and 1996
Industry Energy R&D Program	• Program commitment of $21.7 million to 19 active projects in 1996–1997
Motor Vehicle Fuel Efficiency Program	• Improvement of 1.9 percent in the fuel economy of new vehicles between 1990 and 1996
FleetSmart	• Launch of FleetSmart, to improve the energy use of private sector fleets, in March 1997
Alternative Transportation Fuels Market Development Initiative	• Increase of 162 percent in fuelling stations selling ethanol-blended fuels between 1990 and 1996
Alternative Transportation Fuels R&D Program	• Purchase by Chicago and Vancouver transit authorities of six Ballard fuel-cell buses for technical evaluation
Green Power Initiative	• Issued request for proposals for up to 10 GWh of green power for facilities in Alberta
Renewable Energy Technologies Program	• Development of a perforated-collector active solar technology for heating ventilation air, with annual sales revenue of $2 million in 1996
Community Energy Technologies Program	• Construction begun or completed on four community energy projects
Intergovernmental Cooperation	• Signing of Letters of Cooperation with six provinces • Chairmanship of the Steering Group on Energy Standards of Asia-Pacific Economic Cooperation (APEC) • Signing of Memorandum of Understanding with Mexico on energy efficiency and alternative energy

This report was prepared by the Policy Development and Coordination Unit of the Office of Energy Efficiency (formerly Energy Efficiency Branch), which is managed by Peter Black. The project leaders were Peter Easton, Miles Leznoff and Tim McIntosh. Contributors were John Brennan, Carol Buckley, David Burpee, John Cockburn, Richard Davies, Michel Francoeur, Phyllis Hoshino, Phil Jago, Barbara Mullaly-Pauly, Colleen Paton, Claude Robert, Sue Sim-Nadeau, Chuck Spelay, Robert Stewart, Nathalie Trudeau and John Walsh. Editing, layout and printing services were arranged by Cybèle Vogelsang and Sarah Poirier. Nicholas Marty provided overall direction.

Policy Context

FEDERAL POLICY AND PROGRAMS ON ENERGY EFFICIENCY AND ALTERNATIVE ENERGY

Energy use has been a policy concern since the 1970s. Governments responded to the oil crises of 1973 and 1979 by promoting energy conservation as a means of reducing reliance on imported oil. At the time, energy prices in most consuming countries were regulated at below world levels, making it unlikely that the marketplace would do much, if anything, to improve energy efficiency.

By the mid-1980s, world oil shortages had become world oil gluts. Governments deregulated energy prices and markets, and phased out most energy conservation programs, in the belief that the marketplace, left alone, would attain an optimal level of energy efficiency improvements.

By the end of the 1980s, however, individuals, organizations and governments around the world had become concerned that greenhouse gas emissions produced by burning fossil fuels, such as coal, oil and natural gas, could contribute to climate change.

In 1990, Canada's concern about its greenhouse gas emissions (most of which result from energy use) spurred a major expansion of programs designed to bring down the significant barriers to energy efficiency improvement and to increase the use of alternative sources of energy. This program expansion took into account

- the need for flexibility as programs mature and the implications of global warming and energy efficiency and alternative energy opportunities become clearer;
- international competitiveness and trade commitments; and
- other policy objectives, especially fiscal restraint.

The Energy Efficiency and Alternative Energy (EAE) Program, launched by Natural Resources Canada (NRCan) in 1991, supports economically feasible increases in energy efficiency and the use of alternative energy sources. It encourages investment in corporate and consumer EAE opportunities, and it seeks to engage all sectors of the economy and Canadian society in rethinking and improving energy use (see Appendix 1 for a listing of NRCan EAE program initiatives and expenditures in 1996–1997).

The EAE program uses a variety of policy instruments, including leadership, information, voluntary actions, research and development (R&D) and regulation. In all cases, it emphasizes partnership with stakeholders, such as other levels of government, the private sector and non-governmental organizations. In this manner, the program helps the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices, without reducing service or comfort levels. On the supply side of the energy market, the program ensures that Canada participates in the development of technology for tapping renewable energy sources and alternative transportation fuels, as well as increasing the energy efficiency of energy production.

NRCan's EAE program also provides a foundation for long-term processes that can respond to evolving environmental and economic development priorities. Through the EAE program, the department has enhanced its statutory authority, improved its data-gathering and analysis capabilities, and forged stronger information and planning links with the provinces and other strategic allies.

In 1992, Canada signed and ratified the United Nations *Framework Convention on Climate Change.* Under this convention, Canada and other countries agreed to work to stabilize greenhouse gas emissions at 1990 levels by 2000. On February 20, 1995, federal and provincial ministers of energy and environment approved the National Action Program on Climate Change (NAPCC), which Canada subsequently tabled at the first meeting of the Conference of the Parties to the Framework Convention in Berlin, Germany, in April 1995. The NAPCC sets out the strategic directions Canada will take in pursuit of its objective of stabilized greenhouse gas emissions, and it highlights continuing

and enhanced activities, as well as new and proposed measures. A key element of the NAPCC strategy is the promotion of energy efficiency in all sectors of the economy.

To reinforce the impetus toward voluntary action, federal and provincial ministers of energy and environment agreed in February 1995 to establish the Climate Change Voluntary Challenge and Registry (VCR). This federal-provincial initiative is broadening awareness of the need to act and publicizing the plans and accomplishments of organizations that reduce their greenhouse gas emissions. The VCR invites Canadian companies and organizations to commit themselves to developing action plans to limit their net greenhouse gas emissions, and to filing their commitments, action plans, progress reports and achievements.

The federal budget of February 1997 announced a $60-million, three-year program, commencing April 1, 1998. These additional funds have resulted in new initiatives to provide incentives for energy efficiency improvements in new commercial buildings; encourage commercial building retrofits; provide for energy performance labelling of houses; and stimulate demand for commercially reliable and cost-effective renewable energy systems for space and water heating and cooling.

In December 1997, Canada participated in the third Conference of the Parties to the Framework Convention on Climate Change, held in Kyoto, Japan. Participating countries agreed to reduce greenhouse gas emissions from 1990 levels by the period 2008 to 2012. Canada pledged to reduce its emissions by 6 percent. The Kyoto Protocol applies to the six most important greenhouse gases. Although carbon dioxide accounts for about 80 percent of greenhouse gas emissions, and its reduction is often considered the main solution to climate change, reducing the emissions of such gases as methane and nitrous oxide is important as well. The Kyoto Protocol also allows credit for greenhouse gas sinks, such as forest plantations. To meet the Kyoto challenge on a least-cost basis, all possibilities will need to be examined. The Protocol will enter into force after being ratified by at least 55 parties to the Framework Convention that represent 55 percent of industrialized countries' greenhouse gas emissions. The Protocol will be legally binding on those countries that ratify it.

This report covers progress in energy efficiency and alternative energy measures for the 1996–1997 federal government fiscal year. As such, it does not take into account the energy efficiency targets agreed to by Canada at Kyoto, or the preparations for achieving these targets; that will be the subject of future reports. Achieving the Kyoto targets will not be easy, but NRCan's initiatives under the *Energy Efficiency Act* provide a firm base on which to build the initiatives that will be necessary.

ENERGY EFFICIENCY STRATEGY

Many NRCan EAE initiatives deal solely with energy efficiency. These initiatives are presented in chapters 4, 5, 6 and 7 by end-use sector—residential, commercial and institutional, industrial, and transportation. The goal of these initiatives is to improve energy efficiency by

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles;
- persuading individuals and organizations to purchase more energy-efficient buildings, equipment, systems and vehicles;
- ensuring that energy-consuming equipment is used in the most energy-efficient way (e.g., furnaces are kept well-tuned and vehicles are operated at optimal speeds);
- influencing the energy-use practices of individuals and organizations (e.g., persuading people to use public transit instead of personal vehicles); and
- developing technology that gives consumers, industry and communities new opportunities to improve energy efficiency.

ALTERNATIVE ENERGY STRATEGY

In the short term, energy efficiency improvements can contribute significantly to energy savings and environmental objectives. In the long term, however, reducing greenhouse gas emissions to 1990 levels (or below) will probably require fundamental changes in how we produce and use energy. Among other changes, this may mean using alternative energy sources considerably more than we do now.

Alternative energy includes renewable sources other than large hydroelectric facilities (e.g., bioenergy and solar energy) and new applications of conventional sources (e.g., natural gas used as a transportation fuel). Large hydro is not considered an alternative energy source, since it is already a successful, well-established mode of energy production, supplying over 60 percent of electricity in Canada. Some technologies, especially for forestry biomass and the use of propane and natural gas in vehicles, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Other technologies are still in the early stages of development, and Chapter 8 describes what NRCan is doing to help develop alternative sources of energy and encourage their use.

NRCan directs its activities concerning alternative transportation fuels toward those that are the most technically promising and marketable, such as propane, natural gas and alcohol. Federal initiatives are helping to expand the infrastructure (e.g., availability at fuelling stations) for the sale of these fuels, especially in urban areas, where the increased use of cleaner fuels could alleviate air-quality problems. R&D is focused on ways to improve the options available for these fuels. NRCan is assisting the development of methanol and hydrogen fuel-cell technologies and electric vehicles, all long-term projects.

It is generally recognized that renewable sources of energy, such as hydraulic, biomass, wind and solar energy, do much to mitigate climate change. NRCan allocates most of its support for renewable energy to R&D to reduce costs, improve performance, develop safety and performance standards, and increase the scope of renewable energy technologies. The department also disseminates reliable information to consumers and assesses economic and environmental aspects of renewable sources of energy.

In November 1996, NRCan released its *Renewable Energy Strategy—Creating a New Momentum*, a strategy to promote a strong and viable renewable energy industry in Canada. The strategy calls for the department to act as a catalyst in the development and marketing of renewable energy technologies. It aims to improve the environmental performance of the energy sector, and to enhance the sustainability and diversity of Canada's energy mix. To advance renewable energy performance and reduce costs, the government will continue to support R&D activities. To expand consumer awareness and market acceptance, it will continue its information activities and support deployment of renewable energy technologies.

Under the strategy, NRCan provided advice to the Department of Finance on changes to the taxation system to improve the treatment of investments in renewable energy systems. NRCan also launched a Green Power Initiative, under which it is displacing some of the electricity it purchases from sources that emit greenhouse gases to those that produce power from renewable energy sources. Finally, as noted earlier, a new initiative—the Renewable Energy Deployment Initiative—was put in place on April 1, 1998, to stimulate demand for renewable energy systems for space and water heating and cooling.

NRCan's key policy tools are these:

- leadership;
- information;
- voluntary initiatives;
- regulation; and
- research and development (R&D).

LEADERSHIP

Leadership means setting an example for other levels of government and for the private sector by increasing the energy efficiency and use of alternative energy in federal government operations.

INFORMATION

NRCan disseminates energy efficiency information to consumers, using methods that range from broad distribution (see "NRCan Publications and Exhibits") to individual consultations with clients. The means is chosen to suit the client.

NRCan Publications and Exhibits

NRCan is engaged in a broad range of marketing activities to promote EAE. These activities include publications, exhibits, program documentation and promotional products.

NRCan produces and markets numerous publications for the public as well as for more specific audiences. Publications offer information on such topics as home energy efficiency, energy-efficient office equipment, heating systems, appliances, lighting, energy-efficient transportation and alternative transportation fuels.

NRCan's national exhibits feature EAE initiatives, including Reno$ense, R-2000 Homes, EnerGuide, the national energy codes, Energy Innovators and Auto$mart.

During the 1996–1997 fiscal year, NRCan distributed 1.8 million copies of more than 300 EAE publications.

VOLUNTARY INITIATIVES

NRCan works with companies and institutions on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary initiatives for EAE target large consumers of energy in the commercial, institutional and industrial sectors, and organizations whose products (e.g., houses, cars, equipment) are important determinants of energy use. In a typical initiative, a company or institution (or a group of companies or institutions) will volunteer or agree to take action to help meet certain societal objectives. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target-setting. NRCan provides a variety of support services to assist and stimulate company action, including standards and training development.

REGULATION

Regulation involves setting energy performance levels and labelling requirements for certain types of equipment, and working with provincial governments to improve the energy efficiency provisions in Canadian building codes.

The *Energy Efficiency Act* gives the federal government the authority to make and enforce regulations concerning EAE, primarily the establishment of performance and labelling requirements for energy-using products (as well as doors and windows) that are imported or shipped from province to province. The Act also requires the collection of statistics and information on energy use and alternative energy.

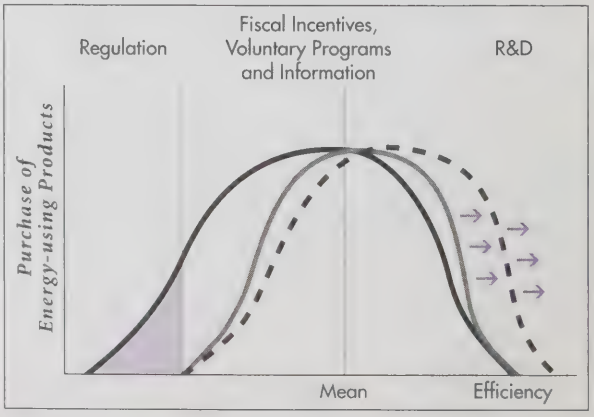
R&D

NRCan EAE initiatives support the development and deployment of more energy-efficient equipment, processes and technologies. R&D is fundamental to the development and use of energy resources. It provides the scientific knowledge base necessary for the development of technologies, codes, standards and regulations that support energy uses that comply with sustainable development principles.

NRCan provides national leadership in energy R&D through its own laboratories, S&T activities that it contracts out and the federal Program of Energy Research and Development (PERD). PERD is the only federal interdepartmental S&T investment fund focused on the energy sector and its economic and environmental effects.

Figure 1 shows how these policy tools work together to increase energy efficiency, that is, how they help to reduce the amount of energy needed to obtain a certain level of service.

Figure 1: Moving the Market



MEASURING PROGRESS

As described earlier, the primary goal of NRCan EAE initiatives is to change energy consumption patterns to obtain environmental and economic benefits. If we are to assess progress toward this goal, we must study three aspects of program delivery:

- program outputs;
- program outcomes; and
- market outcomes.

Program outputs are the items a program produces regularly. To describe program outputs is to outline what is produced, how many are produced, when they are produced and how they are delivered to clients or affected parties. Examples include information and marketing materials, standards, building codes, technology development, workshops, training opportunities, regulations, voluntary agreements, R&D consortia and institutional arrangements with industry associations and provincial governments. Program outputs are important measures of progress, and they are intended to affect behaviour: program outputs are designed to lead to program outcomes—another measure of progress.

Program outcomes are the changes in the behaviour of groups targeted by the programs. These groups may be either energy users or parties that influence the behaviour of energy users. For example, program outcomes occur when consumers purchase more energy-efficient appliances, manufacturers improve information they provide on the energy efficiency of their products, industries set targets for energy efficiency improvements and Canadian energy-efficient technology is sold. Ultimately, these program outcomes affect the amount and type of energy consumed, thus producing a market outcome, the third measure of progress.

Market outcomes reflect the results of programs—changes in energy efficiency and the use of alternative energy. An example of a market outcome is the householder who purchases a more energy-efficient appliance and uses less electricity. The source of electricity and how the utility changed its generation methods to meet the change in demand could lead to a decline in greenhouse gas emissions.

Measuring program outcomes and market outcomes can be difficult. In particular, quantification of program outcomes requires client and data surveys and detailed analyses of energy use. NRCan's National Energy Use Database (NEUD) initiative (see box next page) helps us track changes in energy consumption at a disaggregated level. Nevertheless, it is still difficult to determine the incremental effect of programs because of other factors such as a change in energy prices. Moreover, because several programs can affect a consumer at the same time, the separate contribution of each program to the total effect is difficult to determine.

This report uses a mix of progress indicators, which are quantified where possible. Indicators related to program outcomes and market outcomes were chosen if they seemed to be closely linked to the initiatives being examined. However, the reader should bear in mind the difficulties of determining incrementality and attribution when reviewing such indicators. The challenge will be to improve the coverage and quality of these progress indicators over time.

National Energy Use Database

NRCan launched the National Energy Use Database (NEUD) to support its analytical expertise and improve its knowledge about the end use of energy. The rationale is straightforward—by improving our understanding of where and how energy is used in Canada, the database will reveal opportunities to improve energy efficiency. Over time, the NEUD will help track how effectively the Canadian market addresses these opportunities. It will be an invaluable resource in supporting the development of national efforts to mitigate the impact of energy use on the environment.

To fulfil its objectives, the NEUD has adopted a two-pronged approach that calls for the development of energy end-use data and the establishment of a robust base of expertise for its analysis. In the area of data development, several surveys have been funded through the NEUD:

- Survey of Household Energy Use, 1993;
- Household Equipment Survey, 1994 and 1995;
- New Housing Survey, 1994;
- Homeowner Repair and Renovation Survey, 1995;
- National Private Vehicle Use Survey, October 1994 to September 1996; and
- Industrial Consumers of Energy Survey.

Under the NEUD initiative, a new survey is being developed to support analytical requirements: information on the characteristics of energy-using equipment and buildings in the commercial sector will be collected. Some surveys may be repeated.

The NEUD led to the development of a network of data and analysis centres in universities across Canada. These centres compile, organize and analyze energy end-use data from the residential, agricultural, commercial and industrial sectors, and data on private vehicle use.

NRCan's Energy Efficiency Branch has created a detailed end-use analysis framework that permits contribution to prospective analyses of energy use (such as *Canada's Energy Outlook*), as well as historical reviews of energy efficiency in Canada (such as *Energy Efficiency Trends in Canada*, released in April 1996). The analytical framework organizes existing and new information, and provides guidance for new survey activities.

CHAPTER 2

The *Energy Efficiency Act* and Regulations

THE ACT

The *Energy Efficiency Act*, which came into force on January 1, 1993, gives the federal government the authority to make and enforce regulations concerning the EAE program, primarily

- energy performance levels for energy-using products, doors and windows that are imported into Canada or shipped from one province to another;
- energy labelling of energy-using products, doors and windows that are imported into Canada or shipped from one province to another; and
- the collection of statistics and information on energy use and alternative energy.

Under the Act, before a prescribed product is imported into Canada or shipped from one province to another, the dealer must submit an energy efficiency report that describes the product and its energy performance. Also, dealers who import prescribed products must provide Revenue Canada with an extra copy of the customs release documents, which indicate the nature of the products and the purpose of importation. The copy is forwarded to NRCan for compliance verification.

The Minister of Natural Resources has the authority to designate inspectors to ensure compliance with the Act and Regulations. In addition, the Governor in Council may make regulations regarding

- testing of energy-using products;
- detention, disposition or destruction of seized goods;
- exemptions; and
- implementation of the provisions of the Act.

THE REGULATIONS—ENERGY PERFORMANCE LEVELS FOR EQUIPMENT

Purpose

The purpose of the Regulations is to eliminate less efficient energy-using equipment from the Canadian market by establishing minimum energy efficiency performance levels.

Program Description

Establishing Performance Levels

Regulations under the *Energy Efficiency Act* prohibit the import of and interprovincial trade in energy-using products that do not meet a prescribed level of energy efficiency. The products and levels are established after energy and economic analysis, and consultation with stakeholders. The major stakeholders are the provincial and territorial governments, manufacturers of energy-using equipment and their associations, energy utilities and public interest groups. In choosing products to regulate and efficiency levels to establish, NRCan is guided by considerations of

- energy savings;
- economic attractiveness;
- impact on Canadian manufacturers; and
- harmonization with other jurisdictions, especially the provinces and the United States.

For specified products, the Regulations state the required performance level and testing procedures. NRCan helps develop these standards by funding and participating in standards-writing committees under the auspices of the Canadian Standards Association and the Canadian Gas Association.

In February 1995, NRCan established energy performance levels for the following products, which account for about 65 percent of residential energy demand:

- major residential appliances—electric clothes dryers; clothes washers; integrated stacking washer-dryers; dishwashers; refrigerators,

freezers and combination refrigerator-freezers; and electric and gas ranges;

- space-conditioning equipment—room air conditioners; single-package and split-system air conditioners and heat pumps; ground- or water-source and internal water-loop heat pumps; and gas furnaces;
- water-heating equipment—oil-fired, gas-fired and electric;
- lighting equipment—fluorescent and incandescent reflector lamps; and
- other energy-using equipment—fluorescent lamp ballasts and electric motors.

Regulations under the federal *Energy Efficiency Act* complement energy efficiency regulations in Ontario, British Columbia, Quebec, Nova Scotia and New Brunswick that apply to products sold in each province. They also parallel regulations in the United States. The performance levels for products covered by the federal regulations are largely harmonized with levels prescribed in provincial regulations for the same products. NRCan is developing or considering amendments to these energy performance regulations in six areas:

- adding products that the provinces began regulating after federal regulations took effect in February 1995;
- adding bulged-reflector and elliptical-reflector lamps, and revising the requirements of the classification system for incandescent-reflector lamps;
- adding commercial and industrial products that are identified and ranked in an NRCan-commissioned study by the *Centre de recherche industrielle du Québec* and are not currently regulated in other jurisdictions;
- adding products that are regulated in the United States but not in any Canadian province;
- adding products that are being considered for regulation by the U.S. Department of Energy; and
- increasing performance levels for regulated products.

Compliance—Monitoring and Enforcing Performance Levels

The main activities of the program are monitoring the industry and enforcing the Regulations. These activities are carried out for NRCan by third-party certification agencies accredited by the Standards Council of Canada.

To detect noncompliance, NRCan monitors the industry through various means. The two elements of the compliance system are set out in the Regulations:

- Verification Mark—To ensure that products meet energy performance levels set out in the Regulations, a certification organization must verify the energy performance of the product. A province may also verify the energy performance of a product if the province's energy performance requirements meet or exceed federal requirements. The certification agency must be accredited by the Standards Council of Canada. The verification mark must be placed on the exterior of the product before it is sold or leased.
- Customs Release Documents—Revenue Canada sends NRCan a copy of the completed customs clearance documents that must be submitted by dealers who import a prescribed product. The reports must include specific information:
  - the type of product (e.g., stove, clothes dryer);
  - the brand name of the product;
  - the model number of the product;
  - the dealer's name and address; and
  - the purpose for which the product is being imported.

NRCan's approach to compliance is outlined in "Compliance Policy for the *Energy Efficiency Act* and the *Energy Efficiency Regulations*," released in March 1995. NRCan is committed to achieving a high level of compliance with the Act and the Regulations. The department believes that voluntary compliance is most likely when all parties affected by the Act and Regulations support them. This philosophy is reflected in the following operating principles for administering the Act:

- consulting and cooperating with stakeholders, especially other governments and affected industries;
- minimizing the administrative burden of compliance;
- harmonizing regulations with those of other jurisdictions; and
- informing the public.

Several key elements of the compliance system are set out below:

- Monitoring imports—The *Energy Efficiency Act* and the *Energy Efficiency Regulations* require that dealers report the energy performance of prescribed products to NRCan prior to importation. Monitoring at border points has been instituted in collaboration with Revenue Canada. Products reported on customs release documents are verified against information in NRCan's database to ensure that they meet performance requirements. Officials follow up on cases of noncompliance with regulations or submission of incomplete customs information.
- Third-party monitoring—Third-party monitoring of affected industries is carried out by independent certification organizations that are accredited by the Standards Council of Canada, such as the Canadian Standards Association, the Canadian Gas Association, Underwriters' Laboratory, Warnock Hersey and ETL Testing Laboratories Inc.
- Inspections—NRCan conducts periodic marketplace audits in which qualified inspectors designated by the Minister select products for performance testing in qualified laboratories. NRCan has asked provincial governments to designate inspectors.

Communications

Since the *Energy Efficiency Regulations* came into force, NRCan has produced and distributed information materials on the requirements of the Regulations. Fact sheets have been produced on the following topics:

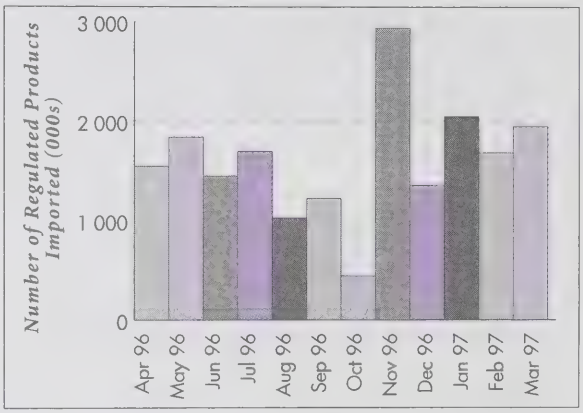
- reports under section 5 of the *Energy Efficiency Act*;
- how to import an energy-using product into Canada;
- energy efficiency verification marks;
- exemptions from the *Energy Efficiency Regulations*;
- EnerGuide labels for energy-using products;
- electric motors; and
- lighting products.

NRCan also distributed a compliance policy document that gives general information on the Act and the Regulations. Finally, NRCan periodically publishes *The EnerGuide Reporter*, a newsletter about the development of standards, regulatory requirements, marketing initiatives and related activities.

Progress Indicators

From information received from Revenue Canada, more than 19 million regulated energy-using products were imported into Canada between April 1, 1996 and March 31, 1997 (see Figure 2). This volume of imports required the processing and review of over 82 000 line items reported on over 12 000 customs documents.

Figure 2: Number of Regulated Energy-Using Products Imported into Canada in 1996–1997



THE REGULATIONS—ENERGUIDE LABELS FOR EQUIPMENT

Program Description

The purpose of the EnerGuide Program is to encourage consumers to purchase energy-efficient equipment. This is done by disseminating information on the energy performance of a range of competing products. The first regulations under the *Energy Efficiency Act* included labelling requirements for eight major household appliances, as well as the introduction of an EnerGuide label, which shows the annual energy use of a product and its ranking on an energy efficiency scale for similar products available in Canada. The eight products are

- electric clothes dryers;
- clothes washers;
- dishwashers;
- electric ranges;
- freezers;
- integrated stacking washer-dryers;

- refrigerators and combination refrigerator-freezers; and
- room air conditioners.

EnerGuide labels for major household appliances describe energy performance in the number of kilowatt-hours (kWh) the appliances consume in a year (see Figure 3). EnerGuide labels for room air conditioners describe energy performance as an energy efficiency ratio (see Figure 4). Both labels give consumers consistent, verifiable energy efficiency information they can use when shopping for appliances.

Figure 3: EnerGuide Label for Appliances

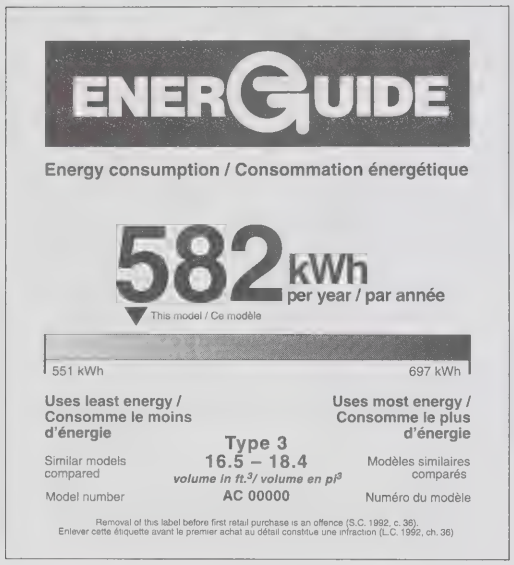
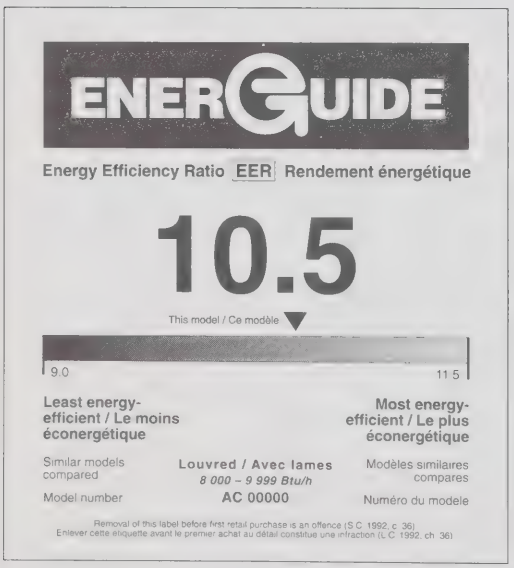


Figure 4: EnerGuide Label for Air Conditioners



The EnerGuide appliance label has two significant features. First, it states the annual energy consumption for that product, based on standard energy efficiency tests. The annual consumption figure lets the buyer calculate the lifetime operating cost of the product model. Second, for consumers who prefer a visual comparison, the label shows the energy efficiency range as a bar with a pointer to indicate how the energy consumption of that model compares with the energy consumption of other models of the same product.

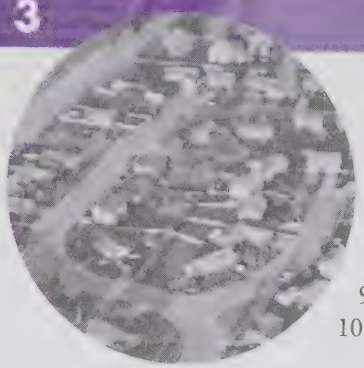
Products that must bear the EnerGuide label are selected in consultation with stakeholders. Marketplace monitoring and enforcement systems are implemented through audits on the frequency of labelling. Comprehensive information campaigns foster consumer understanding of the EnerGuide label and the benefits of energy efficiency. These campaigns involve preparing and distributing publications, media releases and exhibits. In collaboration with its strategic allies, such as provincial governments, utilities, and industry, consumer and standards organizations, NRCan develops training programs to teach retail salespeople how to use the EnerGuide label. Major electric utilities and manufacturers are now considering implementing training programs themselves.

Achievements in 1996–1997

- NRCan designed a prototype Internet web site that importers and brokers or consumers can use to check the energy performance of regulated equipment before it is imported.
- NRCan and Revenue Canada began work on an initiative to share and distribute import data collected from across the federal government.
- NRCan received and processed over 12 000 customs documents for regulated energy-using products in 1996–1997.
- NRCan added 50 000 model numbers to the equipment database.
- NRCan sent about 300 letters to companies to obtain information on prescribed products.
- A marketplace audit revealed that 80 percent of regulated parties complied with the regulations.

CHAPTER 3

Energy Use and Greenhouse Gas Emissions in Canada



INTRODUCTION

Canadians enjoy an abundance of energy from a variety of sources. Our high standard of living is partly attributable to a reliable supply of energy, which is available at reasonable cost.

This comparative advantage has led to the development of industries with particularly strong demands for energy. It has also helped Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. As a result, Canada consumes more energy per capita than most countries.

The importance of energy to Canadians and the Canadian economy is indicated by the amount of money allocated to it. Canadians spend more than $75 billion per year on energy to heat and cool their homes and offices, and to operate their appliances, cars and industrial processes. This represents about 10 percent of our gross domestic product. The economic importance of energy varies from region to region but, wherever it is used, energy is fundamental to our way of life.

ENERGY USE AND GREENHOUSE GAS EMISSIONS

We typically speak of two types of energy use: primary energy use and secondary energy use. Primary energy use represents the total requirements for all users of energy, energy in transforming one energy form to another (e.g., coal to electricity), and energy used by suppliers in providing energy to the market (e.g., pipeline fuel). Secondary energy use is energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings, and in the behaviour of energy users. Primary energy use increased by 15.6 percent between 1990 and 1996, from 9 497 petajoules to 10 982 petajoules.

Secondary energy use accounted for almost 70 percent of primary energy use in 1996. It was directly responsible for about 64 percent of total CO_2 emissions in Canada, 80 percent if we include indirect emissions (i.e., those produced by electric utilities to meet end-use electrical demand). Carbon dioxide is a major greenhouse gas, representing 80 percent of Canada's greenhouse gas emissions. All further references to CO_2 will include both those emissions produced by the electricity used by secondary energy use, and those attributable directly to secondary energy users.

Secondary energy use has increased by 11.4 percent since 1990, but CO_2 emissions attributable to secondary energy use have increased by only 7.2 percent. The emissions increased at a slower rate than energy use because secondary energy users and the electrical generation industry both switched to less carbon-intensive fuels. By 1996, the oil share of secondary energy use had fallen by 2.2 percentage points from 1990 levels, from 37.6 percent to 35.4 percent, and the electricity share also declined slightly. The natural gas share increased to 29.1 percent from 26.9 percent, and the share of other fuels, mainly biomass, also increased. Between 1990 and 1996, the share of electricity generation from coal and heavy fuel oil decreased in favour of natural gas and uranium, fuels with a lower carbon content or none at all.

The industrial sector is the largest energy user, accounting for 38 percent of total secondary energy use in 1996. The transportation sector is the second-largest energy user at 27 percent, followed by the residential sector at 19 percent, the commercial sector at 13 percent, and the agricultural sector at 3 percent.

ENERGY EFFICIENCY

Changes in energy use (and CO_2 emissions) are due to changes in several factors, primarily the following:

- activity associated with energy use;
- the structure of activity;

- weather; and
- energy efficiency—the amount of energy used to provide a given level of service.

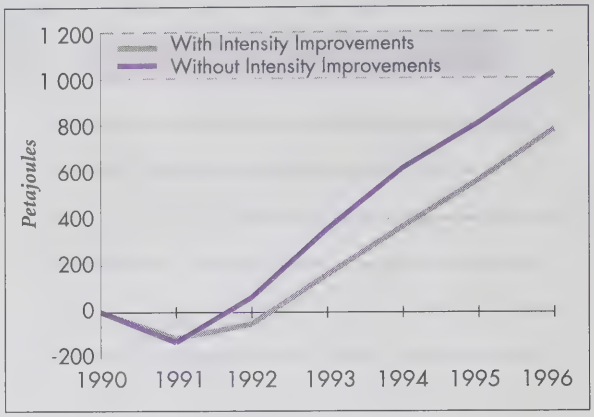
Changes in energy efficiency cannot be measured at the aggregate or sectoral level. Rather, they have to be "netted out" from the other effects. The change in energy use per unit of activity (i.e., energy intensity) is often used as a proxy for the rate of improvement in energy efficiency. However, this is a poor indicator of a change in energy efficiency, since it also incorporates the effects of changes in structure and weather.

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on the change in energy use since 1990, and the contribution of key factors—activity, structure, weather and intensity changes—to the change. Included in this publication is the calculation of an adjusted *energy intensity effect*, which is a better indicator of energy efficiency than energy intensity because it excludes the influence of such factors as the shift in production between industrial sectors and year-to-year differences in the number of days requiring heating.

The increase of 11.4 percent in secondary energy use from 1990 to 1996 was greater than the increase of 6.5 percent in economic growth. This, however, does not mean that Canada became less energy efficient.

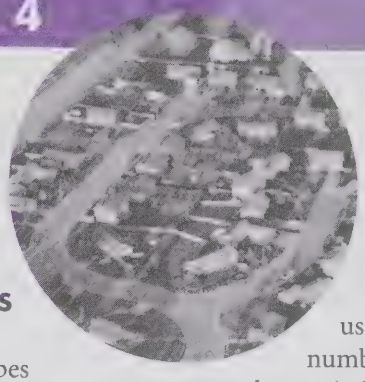
The winter of 1996 was colder than that of 1990, resulting in a greater demand for heating in the residential and commercial sectors. During that period, there was also a shift to more energy-intensive activities in the industrial sector's production mix, and road transport, which is energy-intensive, grew more rapidly than other modes of transportation. Energy intensity, adjusted for these changes in structure and weather, is a better indicator of changes in energy efficiency, and it declined by 2.5 percent between 1990 and 1996. Had this improvement not taken place, secondary energy use would have increased by 15 percent, not 11.4 percent, during this period. This savings of 247 petajoules, which represents cost savings of $4 billion a year, is shown in Figure 5.

Figure 5: Change in Secondary Energy Use, With and Without Energy Intensity Improvements, 1990 to 1996



NRCan's programs contributed to a portion of the savings shown in Figure 5. It is not possible, however, to separate the effects of NRCan's programs from those of other programs or from the changes that take place normally within the marketplace. Moreover, many of the improvements induced by initiatives undertaken between 1990 and 1996 have not had enough time to have had a significant impact on the change in total energy efficiency over this period. Only a fraction of today's capital stock is composed of products that have entered the market in the past few years. It will take many years for recent energy efficiency improvements in new appliances and equipment to affect significantly the average efficiency of the stock of appliances and equipment used by Canadians. For example, new refrigerators being sold in Canada are now 36 percent more energy efficient than those sold in 1990, due primarily to government regulations. However, it will take 15 years or more (the typical life of a refrigerator) before the 36 percent improvement is fully reflected in observed Canadian energy intensity figures. For these reasons, the energy use or CO_2 impact of NRCan's programs from 1990 to 1996 is not, in most cases, quantified in the following chapters. Rather, a number of progress indicators are examined to determine whether these programs are changing consumers' behaviour and advancing the adoption, or likely future adoption, of new technologies that will reduce emissions.

Residential Sector



ENERGY USE AND GREENHOUSE GAS EMISSIONS

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water and operating appliances and lights. The sector accounts for 19 percent of secondary energy use and 17 percent of CO_2 emissions.

The majority of Canadian dwellings are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 6). Because single detached houses predominate, most NRCan residential building programs focus on these dwellings.

More than 80 percent of residential energy is used for space and water heating, followed by operating appliances, lighting and space cooling (see Figure 7).

Between 1990 and 1996, residential energy use increased by 157 petajoules or 12.1 percent. CO_2 emissions from the residential sector rose by 6 percent from 1990 to 1996. The difference between the 6 percent increase in CO_2 emissions and the 12 percent increase in energy use represents a decrease in CO_2 intensity that resulted from a switch from oil to natural gas in the sector, and a switch by the electrical generation industry to less carbon-intensive fuels.

The increase in energy use can be attributed to a number of factors. First, during that period the number of houses (the principal measure of residential activity) increased by 10.2 percent (some 1.2 million units), largely because of population growth. Second, 1996 was a cold year, compared with the average, while 1990 was relatively warm; the number of heating-degree-days, which is a measure of the coldness of the weather, was 13 percent higher in 1996 than in 1990. Changes in the structure of the residential sector also increased energy use, primarily because of an increase in the penetration of appliances and space cooling. Energy intensity (energy use per household) was slightly lower in 1996 than in 1990 but, when adjusted for these factors, declined by 6.3 percent (see Figure 8).

NRCan delivers initiatives to increase energy efficiency in the following subsectors of the residential sector:

- new houses;
- existing houses; and
- residential equipment, including
  - energy performance regulations, and
  - energy labelling.

Figure 6: Households by Type of Dwelling, 1996

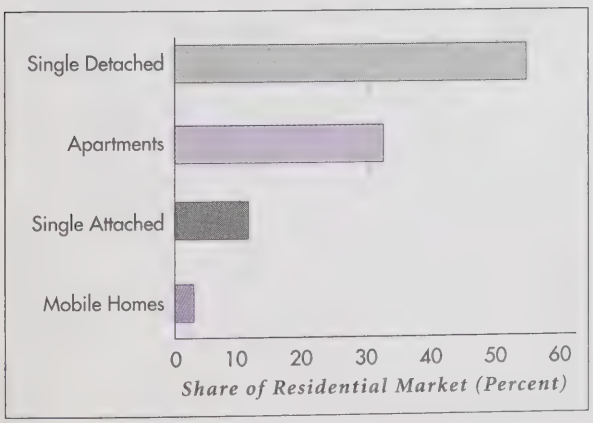


Figure 7: Residential Energy Use, 1990 and 1996

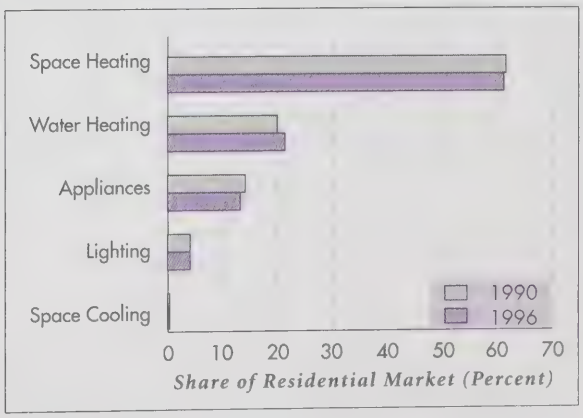
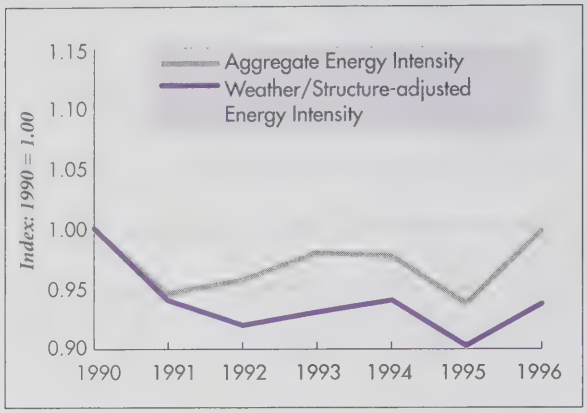


Figure 8: Aggregate and Weather/Structure-adjusted Energy Intensity from 1990 to 1996



NEW HOUSES

NRCan promotes energy efficiency in new houses through the following initiatives:

- Model National Energy Code for Houses;
- R-2000 HOME Program; and
- Buildings Energy Technology Advancement (BETA) Plan—Residential Buildings.

Program Initiatives

In collaboration with energy utilities, provincial and territorial governments, and the National Research Council, NRCan has developed a **Model National Energy Code for Houses** that specifies minimum thermal performance levels. The Canadian Commission on Building and Fire Codes gave the code technical approval in March 1997. Although adoption and implementation of building codes is a provincial and territorial responsibility, NRCan assists provinces and municipalities that wish to adopt energy codes for houses by providing software, training and implementation materials.

The **R-2000 HOME Program** is designed to increase the quantity of energy-efficient and environmentally responsible houses by developing and marketing the voluntary R-2000 standard of energy efficiency. The R-2000 HOME Program offers training for builders and related trades in the techniques and practices needed to meet the R-2000 standard. It also tests and certifies new houses to ensure that they are built to R-2000 specifications. Through promotion, builders and construction trades are encouraged to use the standard and develop the know-how to construct more energy-efficient, environmentally responsible houses. Consumer marketing encourages buyers to purchase R-2000 houses. Research ensures that the R-2000 standard stays at the leading edge of housing development.

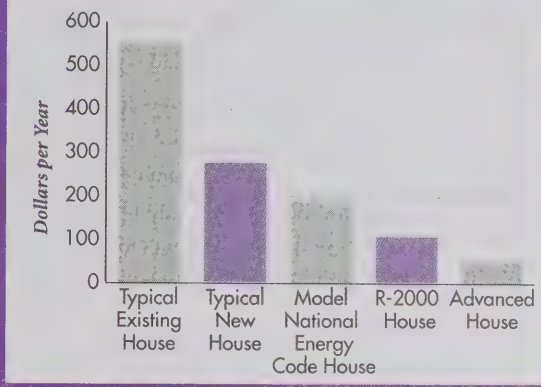
The application of advanced technologies could reduce energy consumption in new residential buildings by up to 50 percent. The **BETA Plan—Residential Buildings** provides technology development, technology transfer and quality assurance to promote energy-efficient and environmentally responsible housing technologies. Priority goes to emerging technologies that can be used in new construction or retrofit projects such as residential space- and water-heating systems, ventilation and windows. Technical support is also provided for initiatives such as the R-2000 HOME Program and the Model National Energy Code for Houses.

Under the Advanced Houses Program, a part of the BETA Plan—Residential Buildings, 10 houses that each use one-quarter of the energy of a conventional house were built, publicly demonstrated and monitored. These Advanced Houses are located in communities across Canada. NRCan now provides support for the commercialization of the technologies identified as most promising during the demonstration program.

Progress Indicators

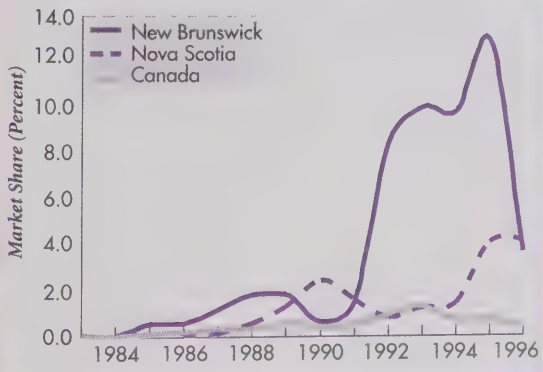
The three programs described on the previous page help reduce energy consumption in new residential units. A new house that meets the model energy code will cost about 30 percent less to heat than a conventional new house. An R-2000 house would cost about 60 percent less to heat, and an Advanced House about 80 percent less (see Figure 9).

Figure 9: Average Annual Heating Cost for Houses Constructed to Different Standards



The proportion of houses completed across Canada in the 1990s that are R-2000 has remained fairly constant at less than 1 percent. At the regional level, however, the proportion of R-2000 housing starts varies considerably, because of variations in fuel availability and prices, and because some regions promote R-2000 houses more aggressively than others. For example, in Nova Scotia and New Brunswick, R-2000 construction is used for 4 percent of new houses (see Figure 10).

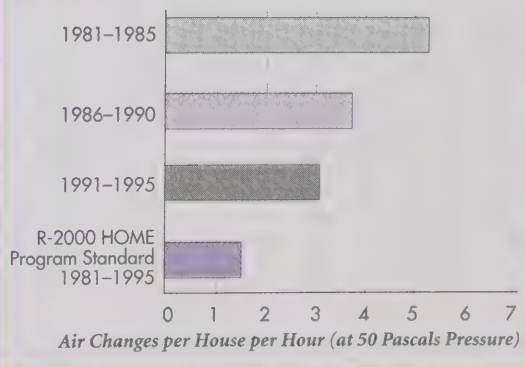
Figure 10: R-2000 Share of National, Nova Scotia and New Brunswick Housing Completions, 1983 to 1996



The proportion in New Brunswick dropped from more than 12 percent to 4 percent in 1996 because New Brunswick Power stopped providing grants for R-2000 houses in that year.

Because it demonstrates readily available, energy-efficient building practices and technologies, the R-2000 HOME Program is more influential than the actual number of R-2000-certified houses would suggest. R-2000 practices and technologies have been increasingly adopted in mainstream housing construction, and many (if not most) new houses now incorporate some R-2000 energy efficiency principles. In recent years, new houses in Canada contained heat-recovery ventilators, equipment that arose directly from R-2000 research. Another indicator of improved overall energy efficiency is that new houses are increasingly airtight. Air leakage is an important element in heat loss, and airtightness has a direct effect on residential energy efficiency. R-2000-certified houses must not exceed 1.5 air changes per hour, and average slightly more than 1 air change per hour. Since the R-2000 HOME Program began, the average number of air changes per hour in all newly constructed houses has decreased from more than 5 to 3 (see Figure 11), and the number continues to drop.

Figure 11: National Trends in Air Leakage in Houses by Period of Construction, 1981 to 1995



Achievements in 1996–1997

- NRCan supported the development of software to facilitate implementation of the Model National Energy Code for Houses.
- NRCan completed a training package for home builders and inspectors on the Model National Energy Code for Houses.
- NRCan and the Manitoba Department of Mines and Energy completed a three-year study of 24 R-2000 and conventional tract houses. R-2000 was found to outperform conventional houses in every category of energy efficiency.
- In 1996, full "Envirohome" features were incorporated into 44 R-2000 houses built in New Brunswick. A collaborative marketing effort of the Canadian Home Builders' Association (CHBA) and Canada Trust with the support of NRCan, Envirohome encourages builders to construct an R-2000-compliant model home that includes the full range of environmental options.
- At the CHBA national conference, Nova Scotia R-2000 builders were awarded the 1996 New Homes Month Award in recognition of their successful R-2000 Showcase of 38 affordable homes.
- In a 1996 Pulse survey conducted on behalf of the CHBA, builders with R-2000 training were found to be twice as likely as those without the training to build houses that are significantly more energy-efficient than local building codes require. More than 300 builders and related trades received R-2000 training in 1996.
- On June 8, 1996, the third Canada–Japan R-2000 Annual Meeting, organized and co-chaired by NRCan, attracted 67 industry and government participants. Participants concluded that, although the number of registered R-2000 houses in Japan remains quite small, more and more "R-2000 type" houses are being built there.

EXISTING HOUSES

NRCan promotes improvements to the energy efficiency of existing houses through the following initiatives:

- Home Energy Retrofit Initiative; and
- BETA Plan—Residential Buildings.

Program Initiatives

The **Home Energy Retrofit Initiative** encourages owners to improve the energy efficiency of their houses during renovation and maintenance projects. Launched in 1995, the initiative provides newsletters on renovation and retrofit and leads consumer information campaigns, national marketing initiatives and demonstration projects.

Under the Home Energy Retrofit Initiative, the Reno$ense marketing initiative encourages consumers to keep energy efficiency in mind when renovating their homes. In 1996–1997, NRCan's Reno$ense partner was the Home Hardware chain of retail stores, so this message was conveyed to Canadians when they were shopping for home renovation products. Reno$ense materials are also distributed through the toll-free publications line maintained by the Energy Efficiency Branch.

The **BETA Plan—Residential Buildings** targets houses that are more than 10 years old, many of which will soon need new heating systems and windows. Houses with electric baseboard heaters and lacking distribution or ventilation systems are a particular challenge. A high priority is the development of audit software for identifying cost-effective retrofit opportunities and supporting the development of the Home Energy Rating System. Research, development and technology transfer activities focus on developing alternatives to electric baseboard heaters and encouraging house retrofits that include high-performance windows and air-sealing techniques. Support is also provided for the development of super-high-performance windows, and for ultra-advanced windows based on emerging technologies such as electrochromics and aerogels.

Achievements in 1996–1997

- In 1996, Reno$ense Planning Centres were placed in 266 Home Hardware stores across Canada to distribute NRCan publications and videos about considering energy efficiency in home renovation. A 16-page tips booklet incorporating messages from private sector sponsors was also produced and distributed. Reno$ense was promoted in Home Hardware flyers, and thus reached a wide cross-section of Canadian households at no charge to the department.
- NRCan worked with window manufacturers to develop a single-number energy efficiency rating for residential windows. This rating was included in the new Model National Energy Code for Houses to specify energy performance requirements based on product costs, energy sources and other local conditions.
- NRCan licenced the HOT 2000 Developer's Kit to Building Insight Technologies Inc. of Vancouver to use in developing its new software. A prototype of the first such product was used for an energy efficiency audit of several hundred houses in British Columbia under two separate initiatives by BC21 Power Smart and BC Gas.
- In partnership with Hydro-Québec, NRCan launched an extensive study of central thermal storage units for residential buildings. These units are electrically heated during off-peak hours and are used for space or water heating in peak demand periods.
- NRCan released CATALOGUE, a new software program that gives builders technical information on the thermal performance of windows.
- NRCan signed an agreement with a manufacturer to develop an air exchanger with heat and humidity recovery for the residential sector. If successful, the technology could lower energy costs and improve indoor air quality for Canadian homes.

RESIDENTIAL EQUIPMENT—*ENERGY EFFICIENCY REGULATIONS*

Program Initiatives

Regulations under the *Energy Efficiency Act* prohibit imports of, or interprovincial trade in, prescribed products that do not meet minimum energy performance levels. Although the regulations eliminate less energy-efficient products, consumers still have sufficient economic choices to meet their needs. The regulations incorporate national consensus standards that include testing procedures to determine the energy performance of the equipment. NRCan fosters development of these standards by funding and participating in nationally accredited standards-writing committees administered by the Canadian Standards Association and the Canadian Gas Association.

Achievement in 1996–1997

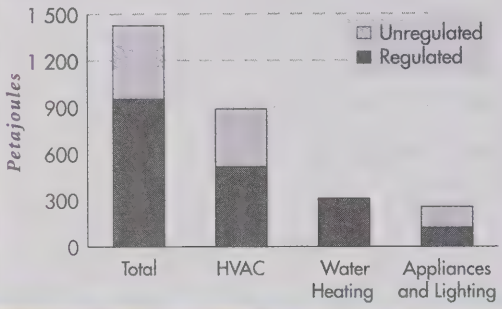
- NRCan conducted comprehensive consultations on the third amendment to the *Energy Efficiency Regulations*, which proposed more stringent energy efficiency levels and establishes energy performance levels for 14 new products.[1] Separate information bulletins for each type of equipment named in the proposed amendment were prepared for distribution to interested parties.

1 Large air conditioners, heat pumps and condensing units, packaged-terminal air conditioners and heat pumps, three-phase split-system central air conditioners and heat pumps, three-phase single-package central air conditioners and heat pumps, gas- and oil-fired boilers, oil-fired furnaces, transformers, and dehumidifiers.

Progress Indicators

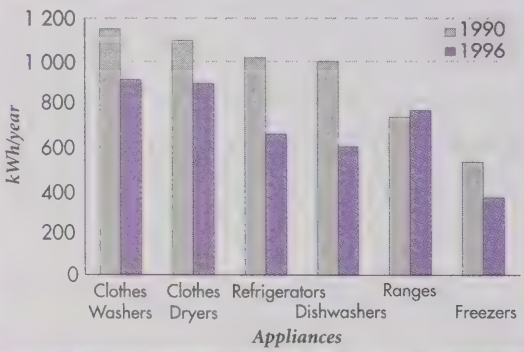
The *Energy Efficiency Regulations* apply to equipment that uses 65 percent of total residential energy, almost all of the energy consumed in water heating, 57 percent of energy used in heating, ventilation and air conditioning (HVAC), and almost half of the energy used to operate appliances and lighting (see Figure 12).

Figure 12: Share of Residential Energy Consumption Subject to the *Energy Efficiency Regulations*, 1996



Regulations have significantly affected the energy efficiency of appliance models. Energy consumption by new appliances has decreased by about 20 percent for clothes washers and dryers, and between 30 and 40 percent for refrigerators, freezers and dishwashers. Energy consumption by refrigerators, which account for 25 percent of appliance energy use, improved by 36 percent between 1990 and 1996 (see Figure 13).

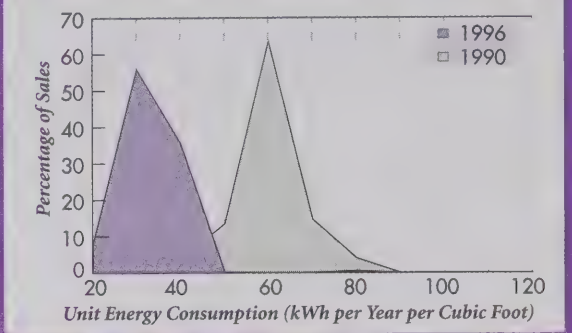
Figure 13: Average Energy Consumption of New Appliances, 1990 and 1996



Regulations, along with EnerGuide, caused a shift in refrigerator sales to more efficient models between 1990 and 1996 (see Figure 14).

Regulations, along with EnerGuide, have contributed to refrigerator energy efficiency

Figure 14: Distribution of Refrigerator Sales According to Energy Consumption, 1990 and 1996



gains of 36 percent since 1990, despite a 7-percent increase in the size of refrigerators over this period (see Figure 15).

Regulations have also greatly influenced the average efficiency of natural gas furnaces. Normal low-efficiency natural gas furnaces have disappeared from the market since 1990 (see Figure 16). The minimum efficiency specified in the *Energy Efficiency Regulations* is 78 percent; the maximum attainable with current technology is 96 percent. The aggregate Annual Fuel Utilization Efficiency (AFUE) for natural gas furnaces in 1996 was 85.5 percent.

Figure 15: Size and Energy Consumption of New Refrigerators, 1990 and 1996

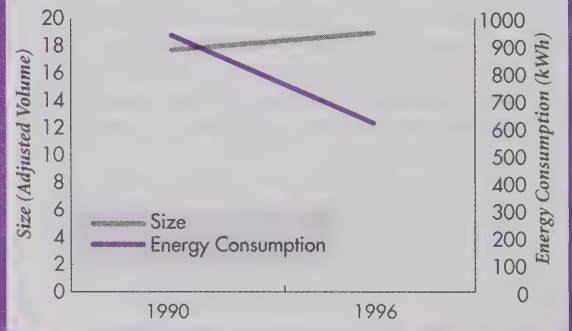
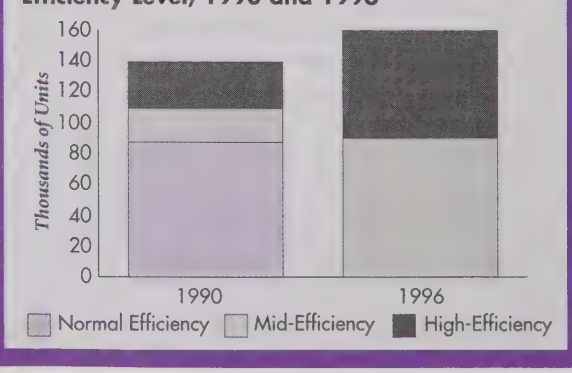


Figure 16: Natural Gas Furnace Sales by Efficiency Level, 1990 and 1996



RESIDENTIAL EQUIPMENT—ENERGY LABELLING

NRCan promotes energy-efficient equipment through the following labelling programs:

- the EnerGuide label for major household appliances and room air conditioners;
- window labelling and certification; and
- EnerGuide ratings for heating, ventilating and air-conditioning equipment.

The BETA Plan—Passive Solar Program provides technical support to these labelling initiatives.

Program Initiatives

The **EnerGuide Program** encourages consumers to buy energy-efficient equipment by giving them information on the energy performance of a product and of competing products of the same class and size. EnerGuide labelling of prescribed major electrical household appliances is mandatory under the *Energy Efficiency Act*. Each year, NRCan updates the information that manufacturers and dealers must include on product labels, and it publishes a directory of all the products in the marketplace that must bear EnerGuide labels, with their energy-consumption ratings. NRCan also conducts comprehensive public information campaigns to explain the EnerGuide label and the benefits of energy efficiency. Working with its partners, NRCan increases the impact of the EnerGuide label at the point of purchase by developing awareness programs for retail salespeople, supporting media campaigns and staffing exhibits for major consumer home shows.

The **Window Labelling Program** encourages consumers to buy energy-efficient windows by giving them information on a product's energy performance. The Canadian Window and Door Manufacturers' Association (CWDMA) initiated a voluntary certification program for windows and patio doors using an energy rating system. A window's energy rating is a measure of its overall energy performance based on three factors: solar heat gains; heat loss through the frame, spacers and glass; and heat loss through air leakage. NRCan and the CWDMA conduct promotional initiatives to market this labelling system.

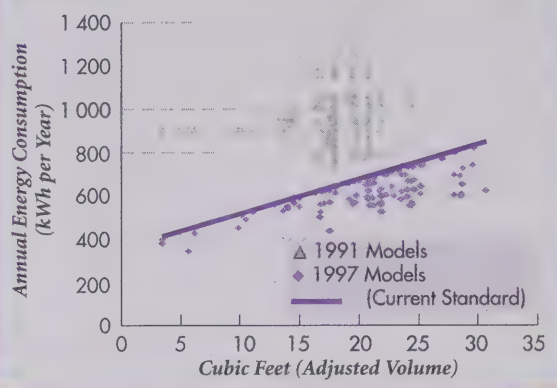
The **Heating, Ventilation and Air Conditioning (HVAC) Energy Efficiency Rating Program** encourages consumers to buy energy-efficient furnaces, central air conditioners and heat pumps by giving them information on the energy performance of these products. This voluntary initiative, launched in 1996, is promoted by the Heating, Refrigerating and Air Conditioning Institute of Canada (HRAI). Manufacturers of HVAC products include the EnerGuide rating in each product brochure to show the range of efficiencies available for the product and the efficiency of the specific product model. Under an agreement with the HRAI, NRCan supports the industry's efforts to promote the EnerGuide rating through a recognition program for manufacturers, and provides training materials and other products and services for dealer education programs. Every HVAC product brochure produced by participating manufacturers since April 1, 1986, has had to include an EnerGuide rating.

The **BETA Plan—Passive Solar Program** helps Canadian innovators develop and disseminate technologies that increase the use of passive solar energy in buildings. Activities include high-performance and advanced window S&T, promotion of efficient windows, commercial building applications, such as daylighting and system integration, and passive solar modelling. A major thrust of the program is to develop product and installation standards for windows and doors. Computer simulation models (VISION and FRAME) were developed as part of the Passive Solar Program as substitutes for laboratory testing. These simulation programs greatly reduce the costs associated with energy efficiency labels for windows.

Progress Indicators

By helping consumers compare products, the EnerGuide labelling program gives manufacturers an incentive to increase energy efficiency. Thirty-one percent of refrigerators with top-mounted freezers manufactured in 1997 had energy consumption ratings at least 10 percent better than the minimum standard (see Figure 17). Similar analyses for dishwashers and clothes washers show that 35 percent of these products have energy consumption ratings at least 10 percent better than the minimum standard. More than 25 percent of all standard dishwashers show EnerGuide ratings that are 26 percent better than the minimum standard. This indicator highlights the synergistic relationship between the *Energy Efficiency Regulations* and labelling programs. Without EnerGuide labels, manufacturers would have little incentive to produce goods that are more energy-efficient than regulations require.

Figure 17: Energy Use Trends for Refrigerators, 1991 and 1997

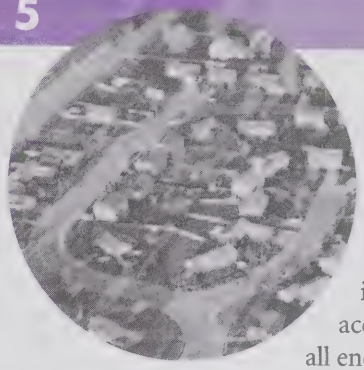


During 1996–1997, five more window and door manufacturers joined the Window Labelling Program, 16 more product lines were introduced, and 121 more certified options (i.e., combinations of features that make up a window model) were offered. The CWDMA commissioned a study that found 1.13 million (32 percent) of the residential windows installed in 1995 were enhanced-energy-efficiency units. These figures are encouraging, but the proportion of manufacturers participating in the program, and of energy-efficient windows installed, remains small.

Achievements in 1996–1997

- All major appliance retailers distributed EnerGuide sales training kits to their sales staff.
- The NRCan Energy-Efficient Home exhibit appeared at more than 10 major home shows across Canada. More than 40 000 EnerGuide information kits were distributed through the toll-free telephone line maintained by the Energy Efficiency Branch.
- NRCan obtained agreement from the Canadian Appliance Manufacturers Association (CAMA) to provide the department with manufacturers' shipment data from 1990 to 1995 for all major electrical household appliances. The data will be used to validate the department's data on energy efficiency improvements.
- Suppliers of more than 90 percent of HVAC products distributed HVAC labelling information.

Commercial and Institutional Sector



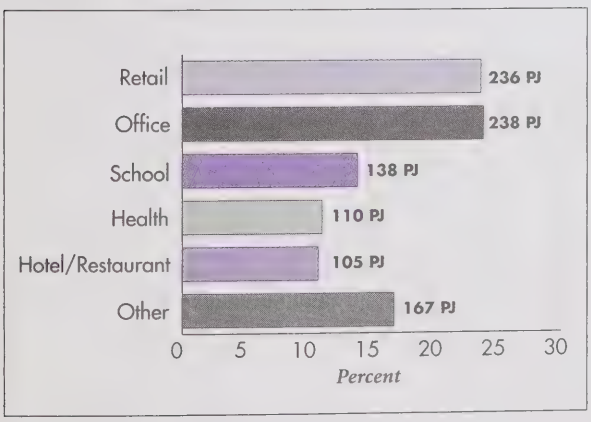
ENERGY USE AND GREENHOUSE GAS EMISSIONS

The commercial and institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. In this sector, energy is used mainly for space and water heating; space cooling; lighting; motive power for services such as pumping and ventilation in buildings; and street lighting.

In 1996, the commercial and institutional sector accounted for 13.1 percent of secondary energy use and 12.4 percent of CO_2 emissions.

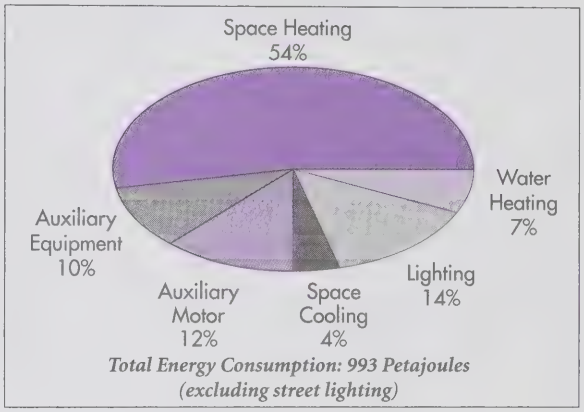
This sector comprises many building types (see Figure 18). Retail and office space account for nearly half of commercial and institutional sector energy demand. Schools, health care facilities and hotels and restaurants account for another 35 percent of energy demand. NRCan programs address all of these major energy-using building types.

Figure 18: Commercial and Institutional Energy Use by Building Type, 1996



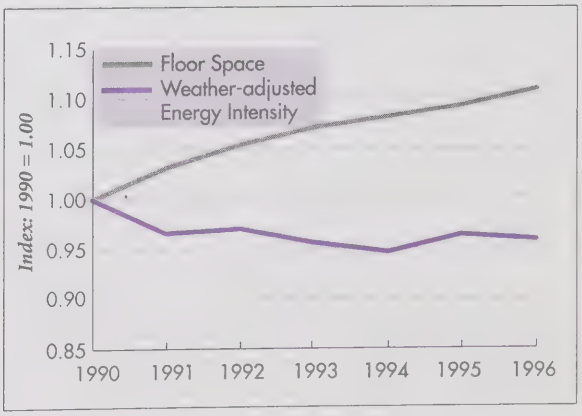
Energy is used for six purposes in commercial and institutional buildings. The largest of these is space heating, which accounts for more than half of all energy demand (see Figure 19). Each of the remaining five purposes accounts for between 4 and 14 percent of energy demand.

Figure 19: Commercial and Institutional Energy Demand by End Use, 1996



Between 1990 and 1996, energy use in the commercial and institutional sector increased by 12 percent, primarily as a result of an 11-percent growth in economic activity (represented by floor space—see Figure 20). CO_2 emissions from the commercial and institutional sector rose by 5 percent from 1990 to 1996. Two factors caused the growth rate of emissions to increase less quickly than the growth rate of energy use. First, the CO_2 intensity of electricity production decreased by

Figure 20: Commercial and Institutional Energy Intensity and Floor Space, 1990 to 1996



12.6 percent and, second, the end-use share of natural gas increased by 2 percent, mostly at the expense of oil.

Weather also contributed to increased energy use, since 1996 was colder than 1990. However, this growth in energy use was moderated by a 4 percent decrease in weather-adjusted energy intensity during the same period.

NRCan delivers initiatives to increase energy efficiency in the following subsectors of the commercial and institutional sector:

- new buildings;
- existing buildings; and
- equipment.

NEW BUILDINGS

Two initiatives address energy efficiency in new commercial and multi-use apartment buildings. These are

- the Model National Energy Code for Buildings; and
- the BETA Plan—Large Buildings.

Program Initiatives

In collaboration with energy utilities, provincial and territorial governments, and the National Research Council, NRCan has developed a **Model National Energy Code for Buildings** that specifies minimum thermal performance levels for commercial buildings. NRCan also provides assistance to provinces and municipalities that wish to adopt the codes.

NRCan's **BETA Plan—Large Buildings** supports the development, commercialization and adoption of energy-efficient, environmentally responsible technologies for large buildings. Its S&T activities are designed to inform builders of the benefits and costs associated with introducing environmentally friendly, energy-efficient technologies.

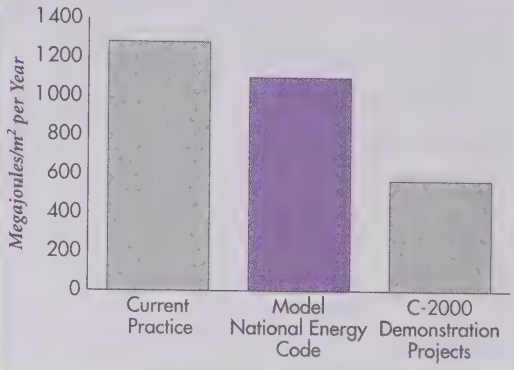
One of the components of the BETA Plan—Large Buildings is the C-2000 Program, which is designed to accelerate the adoption of emerging technologies by demonstrating that energy efficiency, indoor environment and the environmental impact of commercial buildings can be improved. In line with the C-2000 Program, and in partnership with the Canada Mortgage and Housing Corporation, NRCan is challenging industry to increase its standards for energy efficiency, durability, comfort, environment and health in high-rise apartment buildings. The design phase of these two programs indicates that cost-effective energy savings of up to 50 percent are possible.

Progress Indicators

In March 1997, the Canadian Commission on Building and Fire Codes gave technical approval to the Model National Energy Code for Buildings. Among its key features are regionally cost-effective energy efficiency measures that take into account the climate and the cost of energy and construction in each region. As a result, it has comparatively strict minimum energy efficiency levels for expensive energy sources and cold regions.

Provinces and territories have jurisdiction over construction regulations, and, if the model code is to be enforceable, it must be incorporated into provincial building codes. By March 31, 1997, only the City of Vancouver had formally committed to adopting the model code. Commercial buildings that meet the model code could use 15 percent less energy than those built to current standards (see Figure 21).

Figure 21: Energy Use in Commercial Buildings, 1996



Under the C-2000 Program, NRCan invited private industry to develop an advanced commercial building that meets stringent energy efficiency design criteria. C-2000 buildings use about 55 percent less energy than conventional buildings (see Figure 21).

Achievements in 1996–1997

- NRCan completed a training package for HVAC system installers.
- NRCan disseminated HVAC information and demonstrated HVAC software through exhibits and presentations at trade shows and conferences.
- NRCan designed six posters and other information materials on the Model National Energy Code for Buildings for designers and builders.
- The construction of the Crestwood Corporate Centre Building in Richmond, British Columbia, was completed to the strict energy and environmental requirements of the C-2000 Program. The building is expected to consume 50 percent less energy than a conventional building. Performance will be monitored over two years.
- Another building built to C-2000 standards, Green on the Grand, in Kitchener, Ontario, was completed. Simulations show that this building will exceed the C-2000 energy targets and will also demonstrate advances in ventilation technologies and low-emission interior materials.
- NRCan developed energy code software (BILDTRAD, EC2000) that will be used to help designers meet the requirements of the Model National Energy Code for Buildings.

EXISTING BUILDINGS

NRCan encourages energy efficiency improvements in a wide range of commercial and public sector facilities through

- the Federal Buildings Initiative;
- the Energy Innovators Initiative; and
- the Federal Industrial Boiler Program.

Program Initiatives

NRCan estimates that the federal government's annual energy bill is $800 million. Building use is, by far, the largest source of energy demand, accounting for 90 percent of federal energy use. The **Federal Buildings Initiative** (FBI) facilitates comprehensive energy efficiency upgrades and building retrofits for federal government departments, agencies and Crown corporations.

The **Energy Innovators Initiative** (EII) promotes energy efficiency in the commercial, institutional and municipal sectors. The EII encourages Canadian organizations to enrol as Energy Innovators and implement projects that will improve their energy efficiency.

Between them, the FBI and EII provide a wide range of products and services to help organizations plan, finance and implement comprehensive energy efficiency improvements. Besides giving participants energy-management training, FBI and EII promote energy efficiency to organizations by

- developing and disseminating how-to guides, technical fact sheets and case studies of easy-to-replicate projects;
- developing a source list of qualified energy service companies (ESCos);
- exploring project financing and project implementation options;
- presenting workshops and employee awareness programs; and
- maintaining an international database of up-to-date energy efficiency technologies.

Through the Advisory Committee on Energy Efficiency Financing, NRCan works with financial institutions to identify and develop new financing tools to expedite investments in energy efficiency projects. Through a key strategy called "savings financing," public- and private-sector organizations can use energy savings to pay for the projects they implement. Furthermore, under an energy performance contracting arrangement, organizations can mount an energy retrofit project without incurring up-front capital costs. Financing can be obtained through the ESCo engaged in the energy performance contract. The project is repaid from the energy savings that are guaranteed by the ESCo.

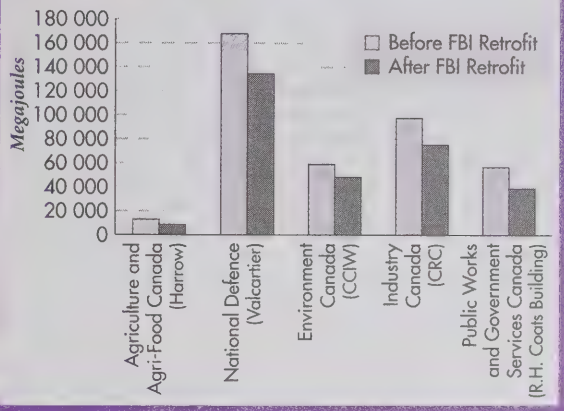
Under the **Federal Industrial Boiler Program** (FIBP), NRCan helps public- and private-sector clients develop and implement clean, energy-efficient heating and cooling technologies. The program develops site-specific strategies to meet high-performance targets and provides turnkey project-management services for new or retrofit combustion technologies. These services include preparing technical specifications, reviewing tenders and supervising the installation and commissioning of new equipment. Other services are cogeneration feasibility studies, retrofit studies, non-destructive examinations of heating-plant equipment, life-cycle costing studies, boiler efficiency audits, on-site test burns, and technical workshops and seminars.

The Canadian government owns 52 central heating plants, housing more than 270 boilers that consume more than 8000 terajoules of fuel annually. Services delivered under the FIBP help government departments to adopt current heating technologies that would reduce nitrous oxide emissions by 50 percent, increase energy efficiency by up to 15 percent, and reduce operating costs by 20 percent, compared with conventional practices.

Progress Indicators

The federal government owns or leases approximately 25 million square metres of floor space, 75 percent of it concentrated in five departments. The FBI has led to cumulative investment commitments of $125 million, which will generate annual energy savings of $20 million. (Figure 22 indicates the expected energy savings from five FBI projects.) Although data on actual savings are not yet available, ESCos guarantee the savings from the FBI retrofits they perform.

Figure 22: Annual Energy Use Before and After FBI Retrofits



Currently, 353 commercial, institutional and municipal participants are registered Energy Innovators (see Figure 23). Forty-two percent of Energy Innovators have implemented energy-saving measures as a result of their association with the program. By the end of 1996–1997, the EII had 14 projects underway, ranging from low-cost awareness programs to comprehensive energy-reduction measures (see Figure 24).

Forty-five new Energy Innovators, many from New Brunswick, joined the program in 1996–1997. In that year, the Government of New Brunswick initiated a Provincial Buildings Initiative (PBI) to extend its energy management program to colleges, hospitals and schools. New Brunswick adopted the FBI model for PBI retrofit projects. Manitoba has a program in place for government facilities, and Nova Scotia, Newfoundland, Quebec, Saskatchewan and British Columbia are designing similar programs.

EII projects reduce CO_2 emissions and energy costs for businesses and institutions (see Table 2).

Table 2
Energy Innovators—Case Study Examples

- The South East Health District in Saskatchewan implemented initiatives that produce annual energy savings of $180 000. This represents energy cost savings of nearly 20 percent and a project payback period of 6.7 years.
- The Toronto School Board is implementing a $180-million, four-phase energy savings program that will displace 260 000 tonnes of CO_2. When all four phases of the project are complete, $20 million in energy costs will be saved annually.
- The retail banking arm of Canada Trust achieved utility cost reductions of about $240 000 annually through $450 000 in direct capital investment for energy upgrades.

Figure 23: Annual Recruitment of Commercial/ Institutional Energy Innovators, 1992–1993 to 1996–1997

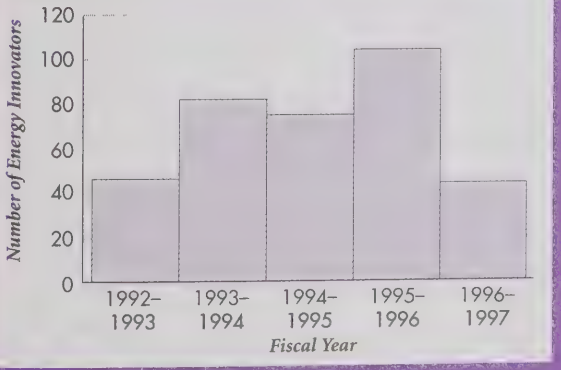
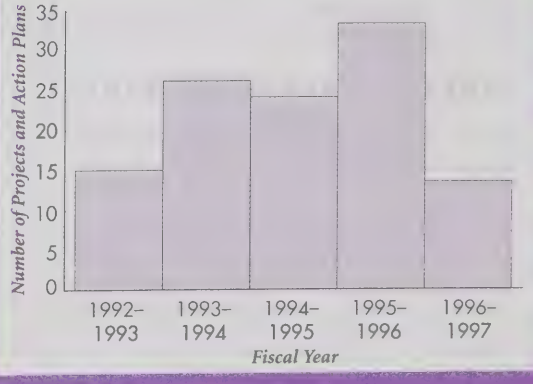
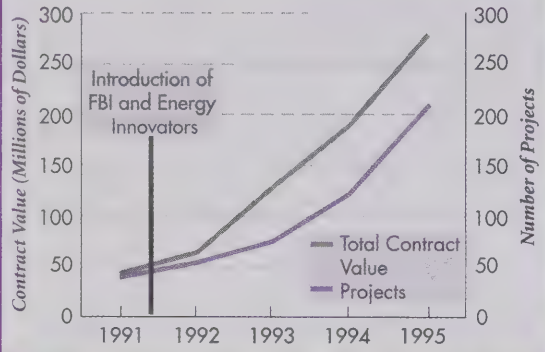


Figure 24: Number of Projects and Action Plans, 1992–1993 to 1996–1997



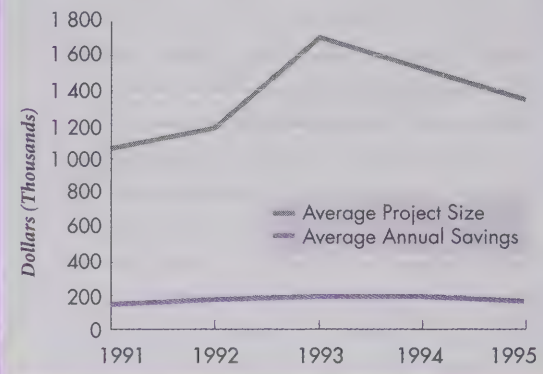
ESCo activity has increased considerably in this decade (see Figure 25). The number of ESCo projects rose from approximately 40 in 1991 to almost 210 in 1995, an increase of more than 500 percent. Even more impressive was the increase in contract values, which rose from $41 million in 1991 to about $280 million in 1995, an increase of more than 680 percent. The number of federal government projects, for example, increased by 125 percent, and the number of college projects went up by 22 percent. All of the former and half of the latter are clients of the FBI and Energy Innovators.

Figure 25: ESCo Activity and Contract Values, 1991 to 1995



Average project value peaked at $1.7 million in 1993 and decreased to $1.3 million in 1995. Average energy savings per project remained virtually constant, however, at approximately $200 000 per year (see Figure 26).

Figure 26: Average ESCo Project Size and Energy Savings, 1991 to 1995



Since 1991–1992, the number of annual FIBP projects and their associated energy savings have on average been rising. In 1996–1997, FIBP projects saved 80 terajoules of energy (see Figure 27).

Figure 27: Annual Energy Savings from FIBP, 1991–1992 to 1996–1997

Achievements in 1996–1997

- A March 1997 survey of FBI projects helped to develop a profile and assess progress. Information was collected for 26 FBI projects, representing 5.1 million square metres (one-fifth of all federal government floor space). The study found that
  - the 26 projects will lower energy costs by $8.1 million per annum;
  - the capital costs of the projects will total $64 million (excluding financing costs); and
  - three items (lighting, HVAC equipment and control systems) will account for 63 percent of project capital costs.
- NRCan contracted with the FIBP to improve the energy efficiency of its facilities. Services provided to date include the conceptual design of the thermal fluid installation in the central heating plant in Nepean, Ontario, and the on-site coordination of energy efficiency renovations (e.g., ventilation improvements, solarwall installations, low nitrous oxide boiler installations, upgraded digital control systems and water fixture replacement).
- The FIBP provided turnkey project management for the design, tendering, procurement, installation, commissioning and acceptance testing of two low nitrous oxide heating systems at federal facilities in Calgary, Alberta, and Ottawa, Ontario.
- The FIBP completed three retrofit surveys, two non-destructive examinations, a cogeneration feasibility study, a life-cycle costing study and a comprehensive investigation of a boiler explosion for government and private sector clients.

EQUIPMENT

NRCan encourages the development and use of energy-efficient equipment in commercial and institutional buildings through the following initiatives:

- *Energy Efficiency Regulations*; and
- the Heat Management R&D Program.

Program Initiatives

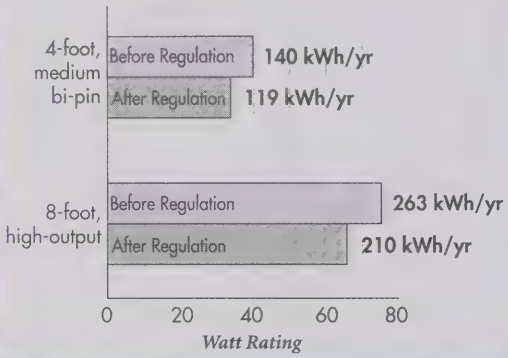
Energy Efficiency Regulations under the *Energy Efficiency Act* prohibit imports of and interprovincial trade in prescribed products that do not meet minimum energy performance levels. Although the regulations eliminate less energy-efficient models of equipment, consumers still have sufficient economical choices to meet their needs. The regulations incorporate national consensus standards that include testing procedures for determining the energy performance of the equipment. NRCan fosters the development of these standards by funding and participating in nationally accredited standards-writing committees administered by the Canadian Standards Association and the Canadian Gas Association.

The **Heat Management R&D Program** develops and promotes the use of advanced heat-management technologies, including advanced heat pumps, heat storage units and heat exchangers; energy management control systems; modelling and simulation of equipment and processes; and optimization of equipment, systems and process application. A major thrust of the program is the development of heating and cooling equipment that uses alternative energy sources, such as absorption heat pumps and desiccant cooling.

Progress Indicators

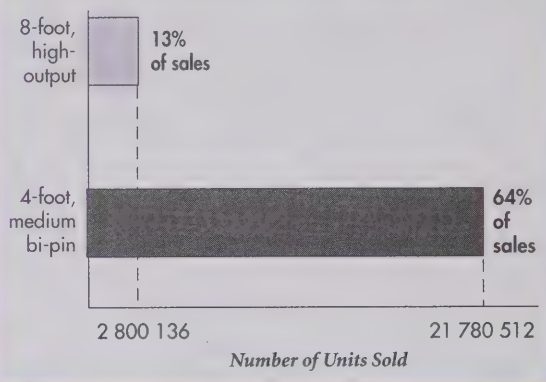
The first *Energy Efficiency Regulations*, which took effect in February 1995, covered two commercial energy-using products, electric motors (discussed in Chapter 6) and fluorescent lamp ballasts. Minimum performance requirements for fluorescent lamps took effect on February 1, 1996, and for incandescent reflector lamps, on April 1, 1996. The fluorescent lamp regulations reduced annual energy use by 20 percent for the 8-foot, high-output lamp and by 15 percent for the 4-foot, medium bi-pin lamp, two of the most popular fluorescent lamps (see Figure 28).

Figure 28: Influence of Lighting Regulations on the Energy Use of Two Fluorescent Lamp Types, 1996



Recent sales data suggest that these two regulated high-efficiency lamps account for more than three-quarters of all lamp sales. The 4-foot, medium bi-pin fluorescent lamp accounts for almost two-thirds of the market (see Figure 29).

Figure 29: Annual Sales and Market Share of Common Fluorescent Lamps, 1996



NRCan estimates that these regulations will result in net energy savings of 10 petajoules and a net reduction in CO_2 emissions of 5.3 megatonnes in the year 2000 (see Table 3). This reduction in emissions is equivalent to the annual CO_2 emissions of more than one million cars.

Table 3
Savings Arising from Federal *Energy Efficiency Regulations* Related to Lighting

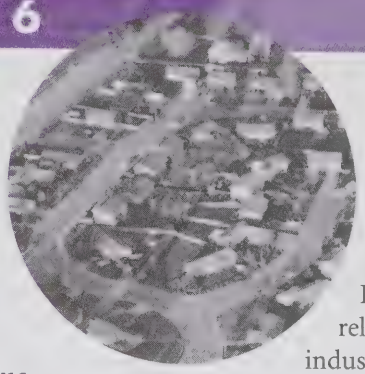
Annual sales of lamps affected by regulations	= $33 million
Estimated direct savings of electricity used for lighting in 2000	= 39 petajoules
Estimated net energy savings in 2000*	= 10 petajoules
Estimated net reduction in CO_2 emissions in 2000	= 5.3 megatonnes

* The estimate of net energy savings is lower than the estimate of direct savings of electricity because the direct savings of electricity are partially offset by an increase in space-heating demand required because more efficient lighting emits less heat. When this effect is taken into account, estimated energy savings are less. The net effect varies by region and building.

Achievements in 1996–1997

- Delta Controls of Surrey, British Columbia, and NRCan signed a task-sharing agreement to commission and implement a building emulator, a hybrid software/hardware system for testing advanced control algorithms for buildings. Advanced controls can result in significant energy savings, lower maintenance costs and increased occupant comfort in buildings. The emulator will allow Delta Controls to minimize the development and testing time of new products.
- NRCan hosted the second meeting of the International Energy Agency Annex 34 working group. The meeting was entitled "Computer-Aided Evaluation of HVAC System Performance: The Practical Application of Fault Detection and Diagnosis Techniques in Real Buildings." Numerous studies show that energy consumption and occupant comfort can be improved when the operational state of a building is properly evaluated and corrective actions are taken through the control system of the HVAC complex. The working groups' representatives from 10 countries test various algorithms and methodologies for the proper operation and commissioning of buildings.
- NRCan commenced work on a five-year development and demonstration project entitled "Advanced Intelligent Controls for Commercial Buildings: Development, Demonstration and Impacts." Other project partners include Public Works and Government Services Canada and the National Research Council. The objectives of this project are to develop, field test, assess and demonstrate an integrated range of intelligent controls for use in the next generation of building-control systems.
- In partnership with Hydro-Québec, NRCan launched an extensive study of central thermal storage units for buildings. These units, which are electrically heated during off-peak hours, are used for space or water heating in peak demand periods. The study is examining their operating characteristics and optimum control algorithms. Control module manufacturers are showing great interest in the preliminary results.
- NRCan and Micro-Thermo, a Montreal-based manufacturer of control systems for refrigeration equipment for food retail stores, jointly launched a project to produce advanced control strategies to help reduce heating and cooling costs associated with the operation of retail equipment such as display cases and refrigeration racks. The goal is to develop an integrated solution for energy and facilities management for large supermarkets. Several Canadian and U.S. organizations are demonstrating interest in testing and eventually acquiring the final product.

Industrial Sector



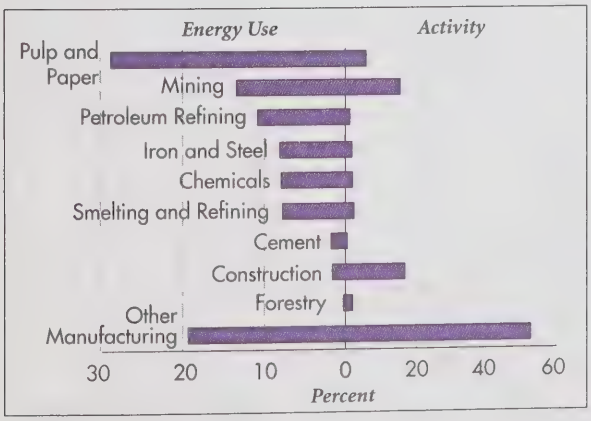
ENERGY USE AND CO_2 EMISSIONS

The industrial sector includes forestry, construction and mining, as well as all manufacturing. This sector uses energy in industrial processes as a source of motive power, to produce heat or to generate steam. Overall, industrial energy demand accounts for 38 percent of secondary energy use and 33 percent of CO_2 emissions.

Manufacturing is the largest energy user, accounting for 85 percent of industrial energy use in 1996. Manufacturing comprises six large, relatively energy-intensive single-industry subsectors, plus one other subsector that includes all other manufacturing. The six large single-industry subsectors are cement, smelting and refining, chemicals, pulp and paper, iron and steel, and petroleum refining. Mining is responsible for the bulk of the remaining energy consumption (13 percent).

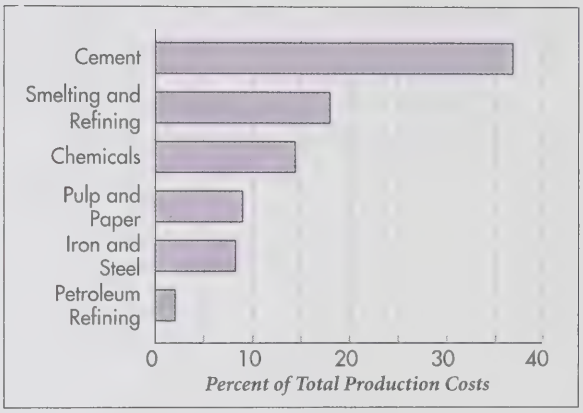
Although these six subsectors, plus mining, accounted for only about 30 percent of total industry activity in 1995, they used 78 percent of total industrial energy (see Figure 30). By contrast, other manufacturing accounted for 53 percent of industrial output, but less than 20 percent of energy use.

Figure 30: Distribution of Energy Use and Activity by Industrial Subsector, 1996



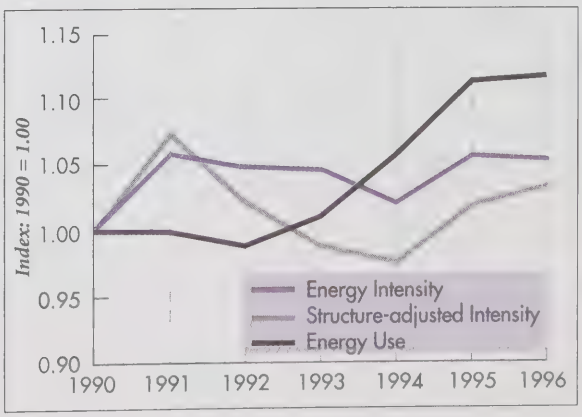
In a few industries, energy purchases account for a large share of production costs (see Figure 31). For some relatively energy-intensive industries, this share ranges from 5 and 10 percent (iron and steel, pulp and paper) to 37 percent (cement). In most industries, however, energy accounts for only a small proportion of total expenditures.

Figure 31: Cost of Energy Used by Industry as a Percentage of Total Production Cost, 1996



After decreasing slightly from 1990 to 1992, industrial energy use increased by about 12 percent by 1996 (see Figure 32). The decline in energy use at the beginning of the decade was caused by the recession that began in 1990. Between 1990 and 1996, industrial CO_2 emissions increased by only 5.6 percent. Emissions grew more slowly than

Figure 32: Industrial Energy Use and Intensity, 1990 to 1996

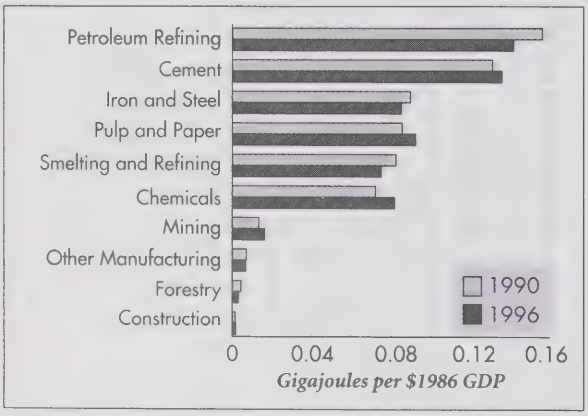


energy use because of fuel-switching from oil products to other, less CO_2-intensive fuels and electricity. Fuel-switching was concentrated in a few industries, especially mining, pulp and paper, and smelting and refining.

Overall industrial energy intensity, measured as energy use per unit of gross domestic product, increased 5 percent between 1990 and 1996 (see Figure 32). The main reason for this intensity increase was fuel-switching and the change in the mix of activity (i.e., structure) toward more energy-intensive industries, specifically pulp and paper, iron and steel, smelting and refining, and mining. If industrial structure had not changed, energy intensity would have increased 3.4 percent.

Some subsectors, including smelting and refining, iron and steel, petroleum refining, forestry, and other manufacturing, noticeably reduced their energy intensity between 1990 and 1996 (see Figure 33). Other subsectors, notably mining and pulp and paper, increased their energy intensity. In the case of mining, this change was largely due to a shift to more energy-intensive components. The mining industry is dominated by oil and gas production, which is more energy-intensive than conventional hard-rock mining.

Figure 33: Industrial Energy Intensity by Industry, 1990 and 1996



A factor that contributed significantly to the increase in energy intensity in pulp and paper production was fuel-switching. For example, there was a shift from oil products to wood waste and pulping liquor. Both of these substitute fuels have a lower conversion efficiency, which means that more secondary energy is required to obtain the same output. As a result, overall energy use increases even though greenhouse gas emissions decrease.

Program Initiatives

NRCan promotes energy efficiency in the industrial sector through

- the Industrial Energy Efficiency Initiative;
- the Industry Energy R&D Program;
- the Emerging Technologies Program;
- the Heat Management R&D for Industry Program;
- the Advanced Combustion Program for Buildings;
- the Advanced Technologies for Process Optimization and Control Initiative; and
- the Minerals and Metals Technologies Initiative.

The **Industrial Energy Efficiency Initiative** (IEEI) provides a framework for voluntary industry action to improve energy efficiency in Canada's industrial sector. The principal components are

- the Canadian Industry Program for Energy Conservation (CIPEC), which coordinates the development of energy efficiency goals and targets, action plans and services for each industrial subsector; and
- the Industrial Energy Innovators (IEI), which transforms subsector-level commitments into company-level action by helping to eliminate company-level obstacles.

Through in-house S&T and repayable financial assistance, the industry S&T programs focus on producing industrial-process heat and using industrial-process heat and cold in the most energy-efficient manner. Areas of research include processes and equipment for advanced stationary combustion, heat pumping, heat recovery and heat exchange.

One industry S&T program—the **Industry Energy Research and Development Program** (IERD)—supports the development and use of new energy-efficient processes, products, systems and equipment proposed by industry. The technologies can be applied in any sector.

The **Emerging Technologies Program** (ETP) identifies technical barriers to increasing the energy efficiency of Canadian industries and supports the development and implementation of technological solutions that contribute to a cleaner environment, improved productivity, higher quality products, reduced waste and a stronger market position for Canadian companies. In particular, the program focuses on energy-efficient technologies that offer the highest rate of return on R&D investment for Canada's industrial sector.

The main purpose of the **Heat Management R&D for Industry Program** is to help Canadian industry develop, commercialize, acquire or use leading-edge heat management technologies and knowledge. In addition to improving energy use and environmental performance, the technologies can enhance the economic competitiveness of Canadian industry. The main delivery mechanism is collaborative, in-house R&D involving manufacturers, service providers and end users in project definition, selection, delivery and financing.

The **Advanced Combustion Program for Buildings** focuses on the development of energy-efficient, environmentally effective technologies. It develops and enhances stationary combustion technologies with a primary focus on pilot-scale applied research projects and field trials. NRCan participates with industry and government clients in joint research projects to help service the residential, industrial and electric-utility sectors that burn fossil fuels, biomass and waste.

Through the **Advanced Technologies for Process Optimization and Control Initiative**, NRCan helps industrial and energy-utility companies reduce their energy use and improve the quality of their output. NRCan develops and supports the adoption by industry of state-of-the-art control technologies such as expert systems, artificial intelligence and advanced computational modelling. Although process-control technologies offer companies immediate opportunities to save energy, process-design changes are needed to achieve a significant reduction. The group leads various consortia of users, technology developers, fuel producers, universities and specialized R&D organizations. The initiative also carries out activities in coke-making and pulverized coal injection on behalf of Canadian coal and steel producers.

The **Minerals and Metals Technologies Initiative** helps Canada's minerals and metals industries improve energy efficiency and reduce energy costs. The initiative's Mobile Foundry Laboratory Program performs 15 to 20 technical and energy audits each year to show foundries where they can save energy and raw materials. Many of the initiative's research projects involve increasing the use of recyclable materials or improving or eliminating industrial processes that use excessive energy. Activities include technology development and pilot-scale demonstration projects with industry that focus on information dissemination, technology transfer and product commercialization. Partners include Canadian companies, especially foundries; provincial governments; energy utilities; and industrial, trade and standards associations.

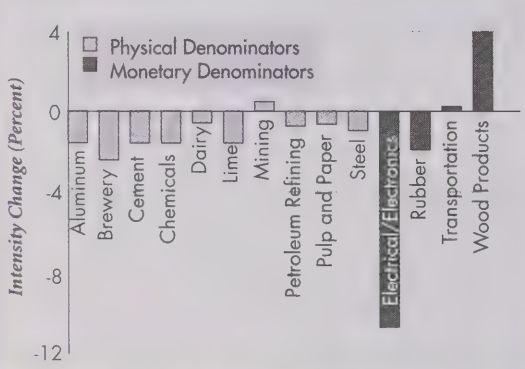
Progress Indicators

CIPEC reports on approximately 90 percent of total industrial energy demand through 20 task forces. Although not all companies in every industrial subsector are CIPEC members, each task force reports progress on the basis of its entire subsector, as defined by Statistics Canada's Standard Industrial Classification (SIC) system.

Data from the Industrial Consumers of Energy (ICE) Survey enables the CIPEC task forces to compare their performance with their energy efficiency improvement targets. Most task forces have made commitments to energy efficiency improvements of 1 percent per year from 1995 to 2000. Exceptions are breweries (3 percent), textiles (2 percent), cement (0.7 percent) and aluminum (0.3 percent).

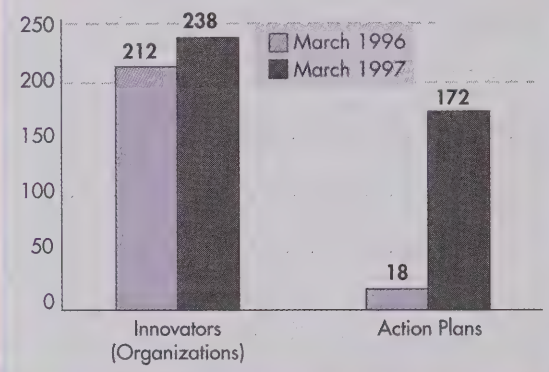
CIPEC's chosen measure of energy intensity is energy use per physical unit of production, where possible. Ten of the 20 task forces report their energy intensity improvements on a physical basis, and most exceeded their target improvement between 1990 and 1996. Only three task forces experienced an increase in energy intensity over the same period (see Figure 34).

Figure 34: Average Annual Intensity Change, 1990 to 1996



By March 31, 1997, 238 industrial companies, representing about 74 percent of industrial energy use, had been recruited as Industrial Energy Innovators (see Figure 35). Over the past year, the IEEI has focused on encouraging participant companies to prepare and implement action plans to realize energy savings. By March 1997, more than 170 participants had prepared action plans that described their proposed energy efficiency projects.

Figure 35: Recruitment of Industrial Energy Innovators and Action Plans, 1996 and 1997



IERD has committed $21.7 million to 19 active projects, of which $16.9 million has been spent. These projects have resulted in estimated energy savings of almost 31 petajoules (see Table 4).

Table 4
Impact of Industry Energy R&D Program in 1996–1997

	Active Projects
Number of projects (1996–97)	19
IERD committed investment	$21.7 million
IERD investment to date	$16.9 million
Estimated energy savings	30.8 petajoules

Achievements in 1996–1997

- In 1996–1997, CANMET tested a hydraulic rock drill, supplied by a South African company, in a 5000-metre drilling test at the experimental mine at Val d'Or, Quebec. Plans to develop a Canadian version of the rock drill are underway. By converting to hydraulic power, mining operations could reduce their total energy consumption by more than 30 percent.
- In 1996–1997, 17 foundries were audited in Ontario, Manitoba, Alberta and British Columbia, using the propane-powered Mobile Foundry Laboratory.
- CANMET developed a high-performance concrete using fly ash, a by-product of the coal-burning process in power plants that normally goes to landfill. The fly ash concrete was used in the construction of the new Confederation Bridge across the Northumberland Strait between New Brunswick and Prince Edward Island.
- Hunter Technologies Inc. of Orillia, Ontario, developed, with IERD assistance, highly efficient gas-fired wall furnaces and gas fireplaces. To date, eight new appliances have been commercialized.
- Inverpower Controls Ltd. of Burlington, Ontario, successfully completed a field trial of an electric arc furnace flicker controller at Lake Ontario Steel in Whitby, Ontario. The field trial, and development of this more energy-efficient controller, received support from IERD funds. Minimizing voltage flicker on electric utility supply lines saves energy by reducing the input line capacity that is required.
- In a separate project, Inverpower completed the development of a more efficient air conditioning controller with improved power quality characteristics. The controller will improve the efficiency and power of adjustable speed drives, used in pump fans and compressors.
- The Avenor mill in Gatineau, Quebec, started a project to develop and implement a computerized model for closer control of the Thermal Mechanical Pulping Process. The work, being conducted by Walsh Automation Inc., Avenor Inc. and the Pulp and Paper Research Institute of Canada, is expected to improve energy efficiency by at least 1.5 percent. It should also improve quality and productivity.
- The Canadian Committee on Electrotechnologies initiated a project to assist with the identification of electrotechnology research and development projects underway in Canada and abroad.
- A technology with wide industrial application and great potential for the realization of energy, quality and productivity benefits is that of artificial intelligence (AI), which consists of high-level computer-based control and decision-making systems. A study conducted by Reduct & Lobbe Inc. of Regina, Saskatchewan, entitled "Advances in the Application of Intelligent Systems in Heavy Industry," updates a 1995 report and is being used as the basis of a pilot program to identify and implement AI systems in Canadian industry.
- NRCan, the CASCADES Paper company of Cabano, Quebec, and the École Polytechnique de Montréal are undertaking a project to reduce CASCADES' need for fresh process water at its cardboard liner mill. Advanced process-integration analysis is being used to evaluate the operations flow of the mill and to minimize energy requirements, waste effluents and environmental impact while maintaining or increasing product quality.
- NRCan will develop a process to remove traces of methane, a potent greenhouse gas, from the exhausted ventilation air of coal mines while recovering large amounts of heat. The system is unique because it recovers methane that is present in low concentrations in the air stream. If successful, the project could eliminate 600 000 tonnes per year of CO_2 equivalent and save $9 million in fuel.
- NRCan signed an agreement with gas utilities, a food processor and a pulp and paper company to develop a new drying technology for hard-to-dry materials such as pastes and slurries. The new technology will cost less than current methods and consume less energy for the equivalent degree of drying.

EQUIPMENT

Minimum energy efficiency standards for some industrial equipment are regulated by NRCan under the *Energy Efficiency Act*. Proportionally, however, fewer items of industrial equipment are subject to energy efficiency regulation than in the residential or commercial sectors.

Progress Indicators

The new amendments to the motor efficiency regulations will raise the efficiency level of industrial motors by about 5 percent (see Figure 36). NRCan estimates that the aggregate energy savings from the amendment to the motor efficiency regulations will be 16.3 petajoules by 2010 (see Figure 37). The estimated reduction in CO_2 emissions resulting from these savings will amount to more than 2 megatonnes in 2010. More than half of the projected energy savings are expected to come from the industrial sector.

Figure 36: Energy Efficiency Standards Before and After Motor Regulations

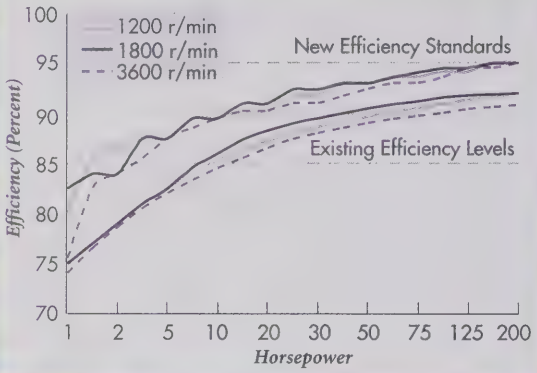
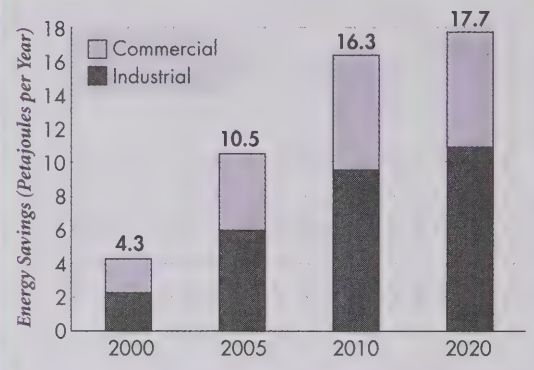


Figure 37: Energy Savings from Motor Regulations, 2000 to 2020

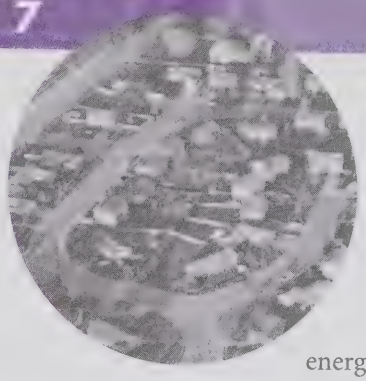


NRCan drafted amendments to existing regulations covering electric motors to clarify the types of motors covered and to adopt the higher performance levels that are currently in effect in Ontario, British Columbia, Nova Scotia and New Brunswick, and will come into effect in the United States in October 1997. The amendments also include changes in equipment dealers' reporting requirements.

Achievement in 1996–1997

- Proposals for amending the *Energy Efficiency Regulations* that apply to electric motors were distributed to stakeholders in October 1996, and the draft amendment was submitted to the Department of Justice for legal review in January 1997.

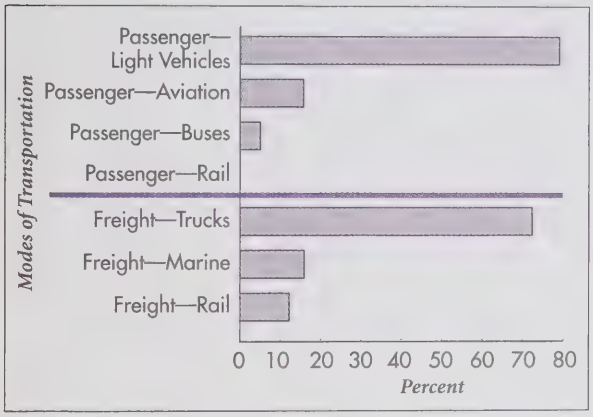
Transportation Sector



ENERGY USE AND CO_2 EMISSIONS

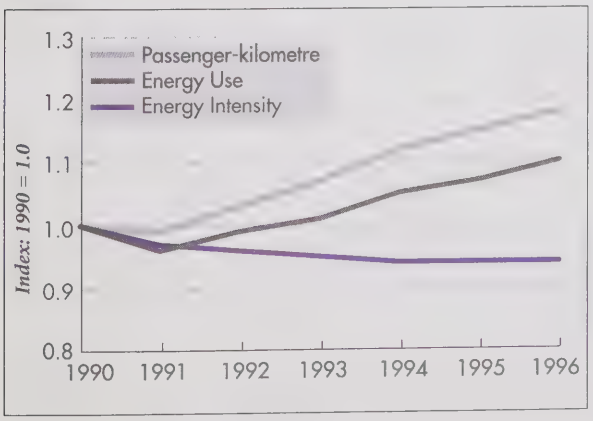
The transportation sector consists of two subsectors, passenger and freight transportation, which are divided into four mode segments: road, rail, air and marine. Road transport energy uses the most; it accounts for 80 percent of passenger energy use and more than 70 percent of freight energy use (see Figure 38). All NRCan transportation energy use programs focus on the energy used in road transportation.

Figure 38: Energy Use by Transportation Mode, 1996



The transportation sector accounts for almost 27 percent of secondary energy use and 34 percent of CO_2 emissions. From 1990 to 1996, transportation energy use increased by 10.2 percent, or 188 petajoules, and CO_2 emissions increased by 10.2 percent. The change in CO_2 intensity of transportation energy use was negligible.

Figure 39: Passenger Vehicle Energy Use and Intensity, 1990 to 1996



Passenger transportation energy use increased by almost 9.8 percent from 1990 to 1996. This change was largely influenced by two offsetting factors: a 17.8-percent growth in activity (measured as passenger-kilometres), and a decline in aggregate energy intensity of almost 5.9 percent (see Figure 39).

NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- personal vehicles;
- commercial fleets;
- transportation efficiency research and development; and
- alternative transportation fuels.

PERSONAL VEHICLES

NRCan promotes the production and purchase of more energy-efficient vehicles and more energy-efficient use and maintenance of these vehicles through

- the Motor Vehicle Fuel Efficiency Program; and
- Auto$mart.

Program Initiatives

The **Motor Vehicle Fuel Efficiency Program**, delivered by NRCan and Transport Canada, encourages motor vehicle manufacturers to meet voluntary annual company average fuel consumption targets for new automobiles and light trucks under 3864 kilograms gross vehicle weight sold in Canada. The annual *Fuel Consumption Guide*, which lists fuel consumption ratings for new vehicles, is produced under this initiative in cooperation with Transport Canada.

Auto$mart helps the motoring public understand how vehicle purchasing, driving and maintenance habits affect the environment. It also offers information on energy efficiency and opportunities to use alternative fuels. The initiative provides information materials and fuel efficiency training for new drivers, and supports private sector initiatives to promote fuel efficiency.

Progress Indicators

The traditional measure of transport fuel economy is litres of fuel burned per 100 kilometres travelled (L/100 km). The most rapid fuel economy improvements using this measure occurred in the late 1970s and early 1980s, mostly because the newer vehicles weighed less and were less powerful than cars built in the 1970s. Cars built in the 1990s tend to be more powerful and, to a lesser degree, heavier, and this trend seems to have slowed new car fuel economy improvements (see Table 5).

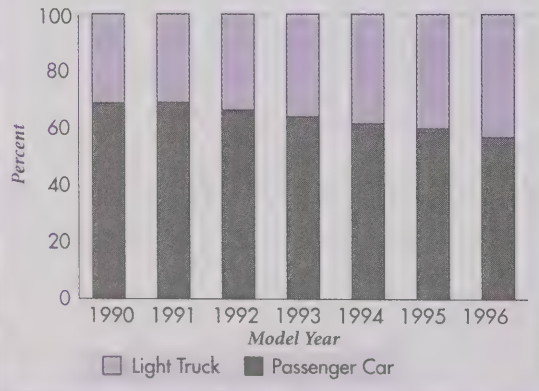
Table 5
Vehicle Vintage and Characteristics*

Year/Vintage	1970s and Earlier Vintage	1980s Vintage	1990s Vintage
Weight (tonnes)	2	1.5	1.6
Horsepower	135	100	140
Weighted average fuel economy (L/100 km)	16.4	10.6	10.1

*"Average new car" from each model year

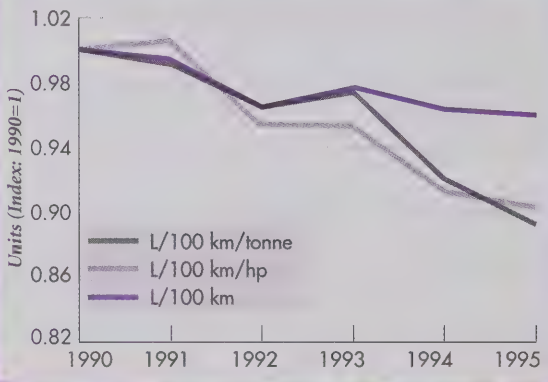
From 1990 to 1996, energy intensity declined in the light vehicle market (cars and light trucks), as more efficient vehicles formed an increasing share of the vehicle stock. The average fuel economy of new vehicles improved by 1.9 percent from 1990 to 1996, and the fuel economy of the vehicle stock as a whole increased by 3.7 percent. These improvements occurred in the face of a trend toward heavier, more powerful vehicles in the 1990s. For example, the share of light trucks in the car and light truck market increased from 31 percent in 1990 to 43 percent in 1996 (see Figure 40).

Figure 40: New Passenger Car and Light Truck Market Shares, 1990 to 1996



Fuel economy measurements typically assume that service characteristics remain fairly stable. In the case of vehicles, however, safety, comfort and performance characteristics have changed considerably. As a result, alternative indicators to the generally used L/100 km are required to account for the changing nature of vehicle transport. Two alternative measures are L/100 km/tonne, which standardizes for weight (and, thus, size), and L/100 km/hp, which standardizes for power. These alternative indicators of fuel economy have shown more rapid improvement than L/100 km. The negative impact of greater vehicle size and weight was more than offset by improved fuel efficiency (see Figure 41).

Figure 41: Fuel Economy of New Cars, Normalized for Size and Power, 1990 to 1995



Promotional efforts play an important role in heightening public awareness of vehicle efficiency. The Auto$mart program provided a great deal of material in this area in 1996–1997, including the *Fuel Consumption Guide* (see Table 6).

Table 6
Auto$mart Communications, 1996–1997

Increase in calls to 1-800 number	100 percent
Publications distributed to private motorists	700 000
Auto$mart Internet site users	1500/month

NRCan initiated negotiations with vehicle manufacturers in 1996–1997 for a new fuel consumption label. Market research was undertaken to test label design options proposed by NRCan and industry representatives.

Achievements in 1996–1997

- For the first time, the *Fuel Consumption Guide* was available through all vehicle dealerships, and more than 425 000 copies were distributed.
- The Energy Efficiency Branch web site added an interactive *Fuel Consumption Guide*, allowing motorists to compare the fuel consumption ratings of new vehicles quickly and directly.
- NRCan completed the development and production of the Auto$mart Student Driving Kit, which includes an instructor's guide, a video and a CD-ROM. The kit will be made available to 5000 driving instructors and driving schools across Canada.

COMMERCIAL FLEETS

The federal government has two programs to increase energy efficiency and the use of alternative transportation fuels:

- FleetWise, for the federal government; and
- FleetSmart, for the private sector and other levels of government.

Program Initiatives

Launched in October 1995, the **FleetWise** program is a federal government-wide initiative to help fleet managers to reduce energy use and promote the use of alternative transportation fuels. The objectives of the program are to:

- improve the operational efficiency of fleets;
- reduce greenhouse gas emissions from fleets; and
- accelerate the use of alternative transportation fuels.

In doing so, the program will help fleet managers meet:

- the federal objective of reducing greenhouse gas vehicle emissions by 30 percent from 1995 levels by 2000;
- the Greening of Government energy and environmental goals; and
- the vehicle acquisition requirements of the *Alternative Fuels Act.*

Progress Indicators

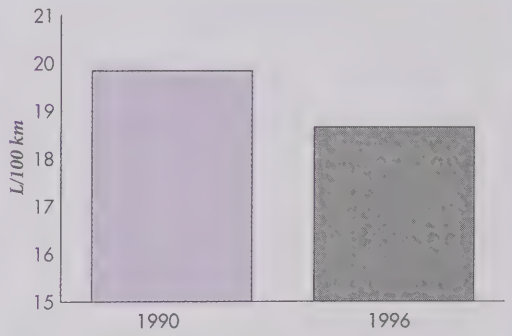
The federal vehicle fleet (that is, on-road civilian vehicles) consists of approximately 25 000 vehicles operated by 15 departments. The Royal Canadian Mounted Police (RCMP) and the Department of National Defence operate 51 percent of the fleet. Only six departments have fleets of more than 1000 vehicles. See Table 7 for additional details.

Table 7
Federal Fleet Characteristics, 1995–1996

Number of vehicles	24 854
Average age	3.8 years
Vehicles driven 20 000 km/yr or less	13 150 (53%)
Vehicles using alternative fuels	517 (2%)
Vehicle purchases	
- 1992–1993	4 000
- 1995–1996	2 500

Energy intensity declined in the federal fleet by 5.9 percent from 1990 to 1996, a somewhat faster rate than in the national vehicle stock. Because the FleetWise program was introduced only in 1995, its influence on this trend cannot yet be measured (see Figure 42).

Figure 42: Energy Intensity of the Federal Vehicle Fleet, 1990 and 1996



Note: Energy intensity is shown in terms of gasoline equivalent.

Four departments—Treasury Board of Canada Secretariat, NRCan, Environment Canada, and Public Works and Government Services Canada—manage planning, implementation and reporting under the FleetWise initiative. NRCan is responsible for implementing FleetWise.

FleetSmart, announced in March 1997, is a parallel program that encourages other Canadian fleet operators to reduce operating costs through

energy-efficient practices and the use of alternative fuels. FleetSmart provides information materials, workshops, technical demonstrations and training programs to help fleet operators assess opportunities to increase energy efficiency in their operations. FleetSmart is delivered in partnership with associations, private industry and other levels of government.

Achievements in 1996–1997

- NRCan completed the first baseline study of the federal vehicle fleet.
- NRCan developed and distributed the FleetWise Planner, a guide for federal fleet managers.
- NRCan and its partners distributed 2500 FleetWise kits to help departments integrate environmental considerations into their operations.
- NRCan developed the FleetSmart Tool Kit, which includes guides on energy efficiency and alternative fuels, fleet success stories and industry case studies.
- In partnership with the British Columbia Trucking Association, NRCan conducted a pilot FleetSmart workshop in March 1997.
- The department established partnerships with fleet and industry associations to facilitate the delivery of FleetSmart.

ALTERNATIVE TRANSPORTATION FUELS

NRCan promotes the development and use of alternative transportation fuels (ATFs) and ATF vehicles through

- the Alternative Transportation Fuels Market Development Initiative; and
- the Alternative Transportation Fuels Research and Development Program.

Program Initiatives

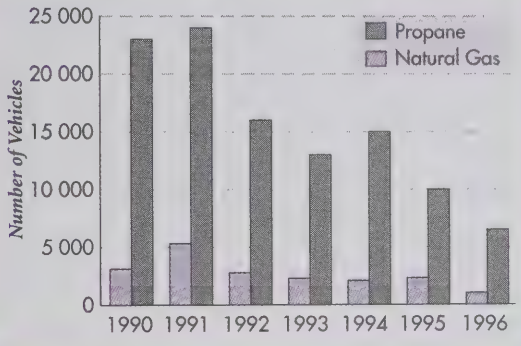
Under the **Alternative Transportation Fuels Market Development Initiative**, NRCan works with the ATF industry and major vehicle manufacturers in Canada to promote propane, natural gas, methanol, ethanol, electricity and hydrogen as automotive fuels. Directed principally to fleet operators in both the public and private sectors, the initiative also attempts to increase public awareness of ATFs. Activities include the development and marketing of original equipment and after-market technologies; regional market demonstrations of natural gas vehicles (NGVs), propane vehicles and methanol vehicles; consumer incentives, such as grants for buying NGVs and installing NGV-refuelling facilities; and communications activities such as publishing. However, 1996–1997 was the final year for substantive grants for natural gas as an ATF.

The **Alternative Transportation Fuels Research and Development Program** supports research and development, field trials, development of technical standards, and technology transfer. The program focuses on the development of competitive, energy-efficient, environmentally friendly technologies for gaseous fuels (natural gas and propane), oxygenated fuels (ethanol and diesel alternatives), and advanced transportation systems (electric vehicles and fuel cells).

Progress Indicators

Conversions of motor vehicles to propane reached a peak of 24 000 per year in 1991 (see Figure 43). Since then, however, the annual conversion rate has declined; it was approximately 6500 per year in 1996. This decline is attributable to several factors, including the recession, the decline in the real price of gasoline and the saturation of the market for propane-fuelled taxicabs.

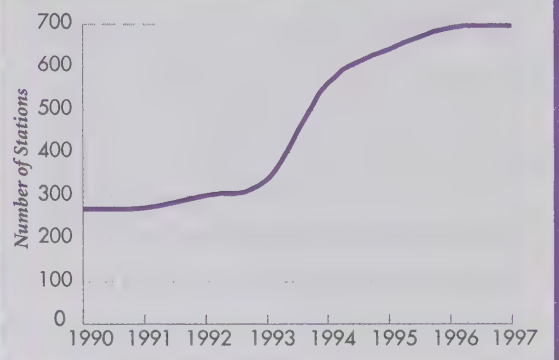
Figure 43: Natural Gas and Propane Vehicle Conversions, 1990 to 1996



Conversions of vehicles to natural gas also peaked in 1991, at 5000 per year. Until 1996, conversions remained relatively constant at 2000 per year and dropped to 1000 in 1996 (see Figure 43). Between 1983 and 1995, NRCan grants for natural gas refuelling stations resulted in a total of 135 stations.

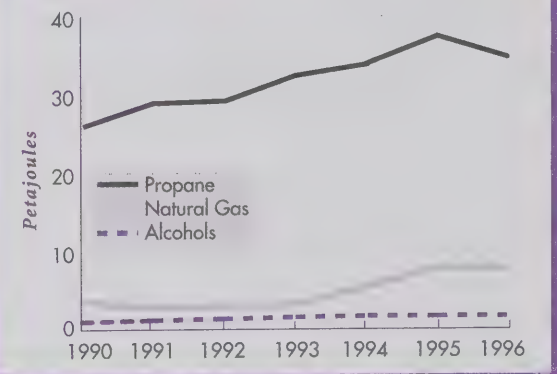
No data on the number of motorists who use ethanol-blended gasolines are currently available. Between 1990 and 1997, however, the number of fuelling stations that sell ethanol-blended fuels increased by 162 percent, to almost 700 (see Figure 44).

Figure 44: Number of Fuelling Stations Selling Ethanol-blended Fuels, 1990 to 1997



The most prevalent alternative fuel (in terms of energy content) is propane. Use of this fuel peaked in 1995 and decreased slightly in the following year (the last for which data are available). Natural gas use has increased since 1990. The use of alcohol fuels increased from 1990 to 1993, and remained constant from 1994 to 1996 (see Figure 45).

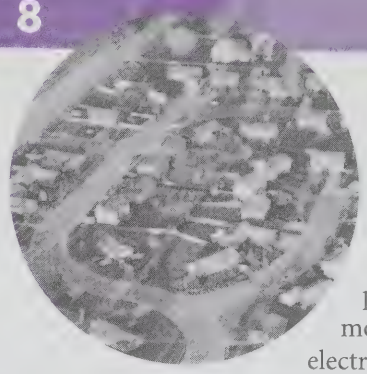
Figure 45: Use of Alternative Transportation Fuels, 1990 to 1996



Achievements in 1996–1997

- NRCan completed the development of the QTOOL software to help fleet managers determine the cost-effectiveness of ATF vehicles. The program has been used extensively by several departments in Ottawa and the regions to monitor compliance with the *Alternative Fuels Act.*
- NRCan, the U.S. Department of Energy and the motor vehicle industry cosponsored the propane and future car student challenges. Teams of university students from Canada and the United States built propane-fuelled or hybrid electric vehicles, either from new designs or by converting production models, and entered them in the technical competition. These challenges generate valuable technical data and provide experience to new engineers.
- Suzuki Motor Corporation, the Saskatchewan Research Council and the British Columbia Research Institute worked together to design and test a natural gas conversion system that was installed in 20 compact cars across Canada. Partial funding for the project was provided by NRCan, Gas Technology Canada and the Japan Science and Technology Fund. The first five converted vehicles went into service at Lordco Parts in Vancouver, British Columbia.
- As part of a consortium including the Detroit Diesel Corporation of Canada Limited, NRCan collaborated on the development and demonstration of a propane-powered version of Detroit Diesel's heavy-duty Series 50 transit bus engine. Metro Transit of Halifax, Nova Scotia, one of the four public transit partners in the project, decided to demonstrate the propane engines.
- The transit authorities of Chicago, Illinois, and Vancouver, British Columbia, each purchased three buses powered by hydrogen fuel cells manufactured by Ballard Corporation of Vancouver and developed with technical and financial assistance from NRCan.
- Stuart Energy Systems developed five different 5-kilowatt cell stack electrolyser units for lower-cost hydrogen production, with funding assistance from NRCan.

Renewable and District Energy



INTRODUCTION

Renewable energy sources provide usable energy without contributing to greenhouse gas emissions, and they do not deplete resources—renewable energy is created from biomass, hydroelectric, wind, active solar, photovoltaic, waste and earth sources.

NRCan delivers several initiatives to encourage the development and use of renewable energy. They are not directed toward the following renewable energy sources:

- large-scale hydroelectricity, a well-established energy source that does not require promotion by NRCan;
- passive solar energy, which is covered by the BETA Plan—Passive Solar program;
- fuel ethanol production from agricultural feedstocks, which is covered by Agriculture and Agri-Food Canada programs; and
- transportation fuels from renewable sources, which are covered by the transportation EAE initiatives.

RENEWABLE ENERGY USE

The renewable energy industry in Canada consists of about 200 companies and employs about 4000 people. (These numbers do not include large-scale hydroelectric projects.) The value of goods and services produced by the industry each year amounts to $1 billion, of which $200 million is exported. In 1995, renewable energy sources accounted for 16 percent of Canada's primary energy supply (see Table 8).

Table 8
Total and Renewable Energy Consumption in Canada

	1990 (petajoules)	1995 (petajoules)
Renewable Energy Sources		
Large hydro	1 030	1 162
Small hydro	25	30
Biomass—industrial use	368	472
Biomass—residential wood use	105	100
Other (wind, solar)	1	5
Total renewable energy	1 529	1 769
Total primary energy	9 082	10 900

Hydroelectricity
Large-scale hydroelectricity projects generate about 11 percent of Canada's primary energy supply and more than 64 percent of its electricity supply. Small-scale hydroelectricity projects, those with a capacity up to 20 megawatts, also contribute.

Bioenergy
Bioenergy is produced by burning biomass (mainly plant materials and waste) or converting the biomass into gaseous or liquid fuels. Bioenergy makes up most of the remaining renewable energy supply not covered by hydroelectricity.

Canada's biomass comes from its enormous forest resources and its large agricultural sector. The forest products and pulp and paper industries produce and use most of Canada's bioenergy. These industries burn their waste materials to produce steam and electricity for their own energy needs, and they sell their energy surpluses. To a lesser extent, bioenergy is also used in the residential sector for heating. More than 6 percent of Canadian single-family homes use wood for primary heating, and another 13 percent use wood as a complement to their heating systems. Bioenergy is also generated from the combustion of other forms of waste, especially municipal solid wastes. As well, fuels are created from landfills and sewage-treatment plants.

Earth Energy
Earth energy is solar energy absorbed by the earth. Ground-source heat pumps use the earth, ground water, or both, as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. The International Energy Agency estimates that 30 000 ground-source heat pumps have been installed in Canada, mostly in the residential sector.

Wind Energy
Because it is reliable and becoming less expensive, wind energy has penetrated markets worldwide since 1985. Wind energy can be harnessed to generate electricity or to provide mechanical power for uses such as water pumping. Because of its size and location, Canada has a substantial wind resource. Most wind energy facilities are based in Alberta, but several other areas of Canada, especially the Gaspé Peninsula in Quebec, are also

suitable locations for wind-generated power. The installed capacity of wind energy in Canada is about 22 megawatts.

Active Solar Energy
Active solar technology converts radiation from the sun into thermal energy, which can warm air and water for residential, commercial, institutional and industrial applications. Canada has more than 13 000 active solar domestic hot water systems and 300 active solar commercial and industrial hot water systems.

Until the early 1990s, the only available solar technology that heated air for space heating was the Trombe wall, a glass covering that would heat the air circulating behind it. Because of unfavourable economics, only a few of these were installed in Canada. In the early 1990s, however, a new, more efficient technology was developed in Canada: the solar pre-heated air ventilation system. Rather than glass, this technology uses metal solar collectors that transfer heat to ventilation make-up air as it flows through perforations in the collectors.

Photovoltaic Energy
Photovoltaic technology, initially used mainly to power spacecraft and satellites, uses solar cells made from semiconductor materials to convert sunlight directly into electricity. In Canada, most commercial applications of this technology are in high-cost areas not served by the electricity grid. Water pumping, telecommunications, lighting and navigational buoys are market niches for photovoltaic technology.

Program Initiatives

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada:

- the Renewable Energy Market Assessment Program;
- the Renewable Energy Information and Awareness Program;
- the Green Power Initiative;
- the Renewable Energy Technologies Program; and
- the Energy from the Forest Program.

The goal of the **Renewable Energy Market Assessment Program** is to review renewable energy use, resources and commercially available technologies to establish their potential for meeting Canada's energy and environmental goals. Activities include compiling data on demand and supply constraints; evaluating market prospects for existing and new technologies; and developing strategies to increase the capacity of the renewable energy sector to meet demand in identified markets.

The goals of the **Renewable Energy Information and Awareness Program** are to expand the use of renewable energy technologies and stimulate industry growth. Activities focus on examining the information needs of market participants (e.g., the public and the renewable energy industry) and preparing specialized information to show how these technologies could be economically and reliably applied to help meet Canada's energy needs.

Under its **Green Power Initiative**, NRCan encourages federal departments to buy electricity generated from renewable energy sources. For its part, NRCan has pledged that it will purchase 15 to 20 percent of its electricity from new green power sources by 2010, where it makes economic sense to do so. Because Alberta seems to have the most potential for successful, competitive renewable energy, NRCan will launch its green power pilot project there.

The **Renewable Energy Technologies Program** supports efforts by those in Canadian industry to develop renewable energy technologies, including bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and bio-gas, and biomass preparation and handling); small hydro projects (less than 20 megawatts); active solar applications; photovoltaics; and wind energy.

NRCan champions and supports technology development and field trials in partnership with the renewable energy industry. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products. Two strategic approaches have been adopted: accelerated penetration of renewable energy technologies into the Canadian market and the exploitation of international opportunities.

Technology development takes several forms, including projects conducted on a cost- or task-shared basis with industry and other partners. Laboratory services supporting photovoltaics are available at NRCan's facilities in Varennes, Quebec; NRCan's biomass laboratory services are in Ottawa, Ontario. These laboratories have state-of-the-art testing facilities to help clients conduct R&D or technology evaluations. NRCan also acts as a catalyst to combine the R&D and funding efforts of other organizations whenever possible, thereby helping industry meet technology development goals more quickly. It also provides technical support for the development of policies and regulations. In addition to private sector companies, NRCan's partners include universities, energy utilities, trade associations, other federal and provincial departments, and research institutes.

To disseminate technology advances within the industry and among potential users, NRCan conducts technology transfer through field trials, workshops, seminars and participation in trade shows. The department also participates in the development of technical standards that help remove trade barriers to Canadian technologies in international markets.

The **Energy from the Forest Program** (ENFOR), managed by the Canadian Forest Service (CFS), undertakes R&D on forest biomass for energy through private sector and university contracts and through CFS activities at five national research centres. Research is being conducted to improve our understanding of the role of the production of biomass for energy and to enhance technologies for intensive silviculture to improve biomass productivity in conventional forest stands and plantations. Two primary sources of forest biomass for energy are under study: forest residues, including harvest residues; and energy plantations, involving short-rotation intensive culture in quick-growing trees such as willow and poplar.

The forest also plays a role in the global carbon cycle that is linked to climate change. To that end, ENFOR seeks to exploit the potential benefits of reducing atmospheric CO_2 emissions. It also investigates the broad environmental effects of harvesting and using forest biomass for energy, focusing on sustaining forest productivity and improving the sequestration and storage of atmospheric carbon in forest ecosystems (biomass and soils). Economic studies offer regional and national perspectives on short- and long-term advantages and disadvantages, including the socio-economic aspects of different biomass energy sources and the use of biomass in communities.

Achievements in 1996–1997

- In partnership with industry and other stakeholders, NRCan funded several market assessments. For example, the study entitled *The Market for Solar Preheated Ventilation Systems in Canadian Remote Communities* demonstrated that, because of the local high cost of energy, remote communities are particularly attractive locations for renewable energy technologies, such as solar heating systems.
- NRCan, three other federal departments and the Assembly of First Nations funded the study *Strategy Options for First Nations Leadership to Catalyze Sustainable Energy Opportunities in Isolated-Grid First Nations' Communities.* The study concluded that more could be done to increase access to renewable energy projects by First Nations communities.
- In June 1996, NRCan sponsored the first Canadian Solar Discovery Challenge, which included renewable energy technology fairs and field trials of photovoltaic-powered vehicles by engineering students at Canadian universities. The event was organized in several Ontario and Quebec cities by the Solar Energy Society of Canada.
- NRCan sponsored conferences and publications by the Solar Energy Society of Canada, the Canadian Solar Industry Association, the Independent Power Producers' Society of Ontario and the Canadian Wind Energy Association.

Progress Indicators

Development of the Green Power Initiative

- Fall 1995: NRCan hosts a workshop to assess the feasibility of a green power purchasing policy for the federal government.
- January 1996: The Minister of Natural Resources announces that the federal government will investigate the feasibility of purchasing electricity produced from renewable energy sources. Departmental officials consult utilities, industry associations and the governments of seven provinces.
- October 1996: The Minister of Natural Resources announces that the department will run pilot projects to gain practical experience in purchasing green power from utilities.
- December 1996: NRCan and Environment Canada sign letters of intent to purchase green power from Ontario Hydro for their facilities in Ontario.
- February 1997: NRCan issues requests for proposals for up to 10 gigawatt-hours of green power for its facilities in Alberta, and Environment Canada requests proposals for up to 3.1 gigawatt-hours.

In January 1996, the Minister of Natural Resources announced federal government plans to purchase green power (see sidebar). In December 1996, after extensive consultations with electric utilities and the renewable energy industry, NRCan and Environment Canada announced plans to run pilot projects in Ontario and Alberta to gain practical experience in purchasing green power. The two departments are interested in purchasing 25 000 megawatt-hours per year of green power for their facilities in Ontario and Alberta. They signed letters of intent with Ontario Hydro in December 1996.

In 1996, NRCan released its *Renewable Energy Strategy—Creating a New Momentum* (see sidebar). During the previous policy review consultations, industry claimed that the taxation system impeded the development of renewable energy because it favoured conventional energy sources. In 1995, with the support of the Department of Finance, NRCan conducted an empirical study of the tax treatment of competing energy investments, issued as *The Level Playing Field—Tax Treatment of Competing Energy Investments*. As a result, the March 1996 federal budget revised certain capital cost allowance rules for renewable energy investments to make them more competitive. In addition, sponsors were allowed to issue flow-through shares on their projects to improve the financing opportunities for certain renewable energy projects. In the February 1997 federal budget, the government set aside $60 million over three years, beginning in 1998, to promote the use of renewable energy systems for heating and cooling and to increase energy efficiency in buildings.

Development of a Renewable Energy Strategy

- 1994: NRCan publishes the background report from the Renewable Energy Policy Review.
- 1995: NRCan presents a draft strategy to industry and other stakeholders.
- January 1996: NRCan announces federal government plans for green power purchasing.
- March 1996: The federal budget includes tax measures for renewable energy.
- September 1996: NRCan and the Department of Finance release *The Level Playing Field* study.
- November 1996: NRCan releases its "Renewable Energy Strategy" document.
- February 1997: The federal budget includes a $60-million, three-year program of energy efficiency and renewable energy measures.
- 1998–2000: NRCan implements new renewable energy initiatives.

A recent Canadian success story is the development of a perforated-collector active solar technology that can be used to heat ventilation air. Between 1992 and 1996, the technology was installed in 19 commercial and industrial buildings (see Table 9). The size of projects increased significantly in 1995 and 1996, leading to annual sales revenues for manufacturers of more than $2 million in 1996.

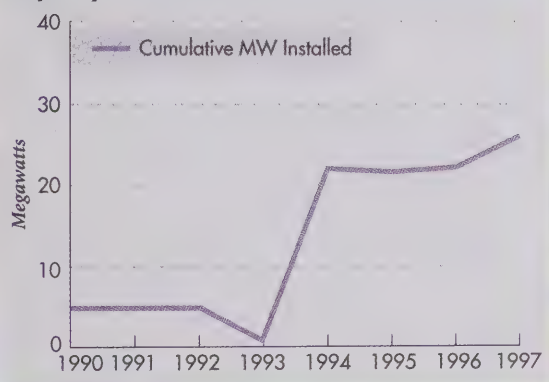
Table 9
Estimated Sales of Solar-heated Ventilation Systems in Canada, 1992 to 1996

	1992	1993	1994	1995	1996
# of units installed	4	3	4	5	3
Average unit cost ($)	90 000	55 000	45 000	120 000	770 000
Average unit size (m^2)	400	225	375	690	3 600
Average cost/m^2 ($)	225	250	125*	176	215
Annual sales revenue ($)	360 000	165 000	180 000	600 000	2 310 000

* 1994 cost does not include air handling systems in 3 of the 4 projects.

Wind power is increasingly becoming a viable option, particularly in remote, off-grid communities. Since 1990, cumulative installed capacity has increased by 560 percent, to its current level of 25 megawatts (see Figure 46).

Figure 46: Cumulative Installed Wind-power Capacity, 1990 to 1997



Canada has an abundance of biomass that could be used for energy production. Our dependence on fossil fuels could be reduced by replacing them with a CO_2-neutral renewable energy source, but biomass is still more expensive to use than fossil fuels. NRCan studies have found, however, that biomass becomes more competitive when forest residues are harvested for energy at the same time as wood is removed for conventional forest products, and when the associated silvicultural and forest improvements are also taken into account.

CFS continued to develop a model of carbon inputs and outputs in the Canadian forest sector to investigate the impact of Canadian forests on national carbon budgets and, eventually, on global climate change. Field studies and computer modelling undertaken over a range of ecosystems have suggested that the forest carbon budget is not in equilibrium but fluctuates over long periods; that Canada's forests at present may be a source of carbon emissions as opposed to a carbon sink; and that fire, insects and harvesting play a major role in the forest carbon cycle. Collaborative activities at the regional and provincial levels were undertaken to examine whether the national model could be applied at the provincial and forest management unit level. The model is now being widely used to help examine and promote the role of bioenergy in global climate change.

- NRCan supported the development of a solar energy exhibit display by Énergie solaire Québec, which this association brought to five exhibitions in 1996–1997.
- NRCan supported the installation of photovoltaic lighting systems near Pine Ridge Secondary School in Pickering, Ontario.
- NRCan distributed the following publications:
  - *A Guide to Residential Wood Heating*: 30 000 copies
  - *Heating and Cooling with a Heat Pump*: 18 000 copies
  - *Photovoltaic Systems—A Buyer's Guide*: 4 500 copies
  - *All About Wood Fireplaces*: 18 000 copies
- The first Solarwall® installation on a Crown-owned building in Canada was completed at NRCan's laboratory complex in Nepean, Ontario. The 700-square-metre installation will supply approximately 35 percent of the building's heat requirements at an efficiency level of between 60 and 70 percent.
- NRCan launched a pilot project to demonstrate the benefits of solar heating at a salmon hatchery on Vancouver Island. The system is expected to save about $8500 annually in oil heating costs. The Department of Fisheries and Oceans, which owns and operates the hatchery, and Environment Canada are funding the project.
- A novel pulse combustion dryer developed by Novadyne of Peterborough, Ontario, with NRCan support, was used successfully to dry waste treatment sludges from the pulp and paper industry, facilitating the environmental disposal of this problematic material.
- Developed with funding and technical support from NRCan, a chip-bin and feed system completed its first year of successful operation at the CANFOR pulp mill in Chetwynd, British Columbia. The chip-feeding and -metering technology has significantly reduced handling and delivery costs for wood chips.
- With support from NRCan and Industry Canada, Simon-Carves Fenco Inc. (SCF) of Willowdale, Ontario, began a commercial-scale field trial of the Queen's University Extraction Fermentation Process. This process was developed by Queen's in cooperation with NRCan, and subsequently licenced to SCF. It could save an estimated 5 to 10 cents per litre of production at fuel ethanol plants, contributing significantly to ethanol's competitiveness.
- ABB of Gloucester, Ontario, and Sandwell Inc., of Vancouver, British Columbia, installed a $50-million, 13-megawatt, fluidized-bed-boiler cogeneration facility using wood waste at Finlay Forest Inc. in Mackenzie, British Columbia. The boiler design is based on work supported by NRCan.
- The 200-kilowatt prototype of a low-cost, innovative, low-head, pit-type hydro turbine was installed by Canadian Hydro Components Ltd. in Almonte, Ontario. The technology was developed with NRCan support. With a head range of two to five metres, the turbine is suitable for use in irrigation and navigation canals.
- A joint venture agreement on small hydro turbine control and protection systems was signed between Canadian Hydro Components and the Hangzhou Regional Centre in China. The agreement covers initial cooperation with the goal of adapting and transferring small hydro control and protection systems to the Chinese marketplace.
- As the operating agent responsible for the Small Hydro Task Force of the International Energy Agency Hydropower Implementing Agreement, NRCan developed an Internet small hydro database. The database distributes information on potential small hydro sites and market opportunities worldwide.
- Under the PV for the North Program, a new, state-of-the-art hybrid power-generating system comprising solar electric, wind and diesel power was installed at the Aurora Research Institute in Inuvik, Northwest Territories, to be used for demonstration and training.
- NRCan completed the report *Overview of the Worldwide Photovoltaic Industry*, which summarizes the current status and prospects of this sector to 2010. More than 350 copies were distributed to Canadian companies, energy utilities and potential investors. One of the principal findings of the report is that the long-term potential of this industry is promising: industry sales have grown 300 percent since 1985 to more than $1 billion annually.

- CFS supported operational trials of technology that would establish energy plantations of willow and hybrid poplar on agricultural land in Ontario and Quebec. Work on hybrid willow in Quebec was completed. Results demonstrated the importance of using pest management controls to maintain production, and the effects and importance of fertilization in maintaining production over a range of soil and nutrient conditions. Work on assessing the status of hybrid poplar plantations was completed, and two promising poplar clones for energy production were identified.
- CFS organized a site productivity workshop to provide a forum in which to present and discuss research results related to the effects on soil productivity of harvesting and removing biomass. The workshop proceedings were published to disseminate information about how biomass production for energy affects the environment, which in turn affects forest productivity.

COMMUNITY ENERGY TECHNOLOGIES PROGRAM

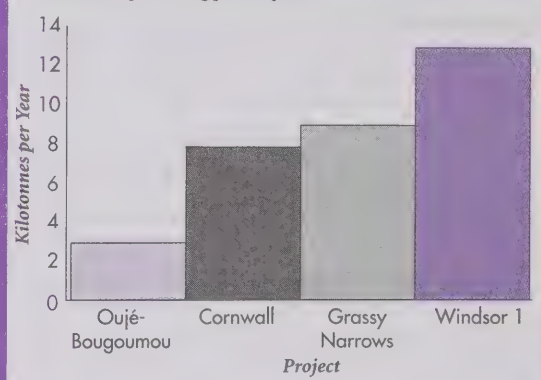
Program Initiatives

The **Community Energy Technologies Program** assists in technology development, technology transfer, financing and marketing options for integrated community energy systems. This program helps Canadian communities become more energy-efficient by applying technologies that connect heat sources and sinks, and by finding ways to satisfy the demand for cooling with efficient, ozone-friendly methods. Technologies include district heating and cooling, the combined production of heat and power, industrial waste-heat recovery and thermal storage. The program works with Canadian industry, energy utilities, researchers, engineers and other levels of government to develop and transfer technology, and to stimulate interest in community-based energy systems. It also evaluates opportunities to develop and install community energy systems, and it provides financial and technical support for implementation.

Progress Indicators

Since 1991, NRCan has provided technical, financial or marketing assistance to many major community energy projects: of these, projects in Oujé-Bougoumou, in Quebec, and in Cornwall and Grassy Narrows, both in Ontario, have been constructed, and construction has begun on the Windsor Utilities Commission project. These projects will result in a cumulative reduction in CO_2 emissions of 33 kilotonnes a year (see Figure 47). In addition, projects in the final stages of development include Sudbury and Hamilton, Ontario, and Revelstoke, British Columbia, as well as a landfill, gas-based project in Brantford, Ontario. The Northwest Territories Power Corporation constructed a project in Fort McPherson, with others under construction in Pangnirtung, Toloyuak and Coppermine.

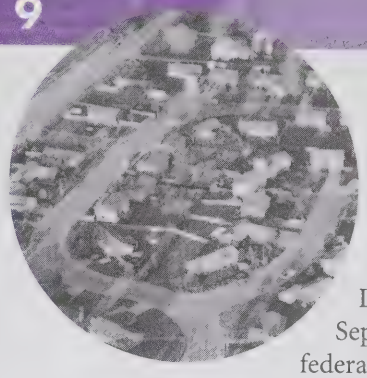
Figure 47: Carbon Dioxide Reductions from Community Energy Projects



Achievement in 1996–1997

- More than 130 people attended the Canadian District Energy Association conference held in Toronto in November 1996.

Intergovernmental Cooperation



INTRODUCTION

Since federal, provincial, territorial and municipal governments in Canada deliver EAE programs, coordination among them is essential to avoid duplication and ensure efficient program delivery.

At the international level, NRCan benefits from cooperation with other countries in two ways:

- It learns about improved ways of designing and delivering EAE programs.
- It helps to reduce trade barriers to energy-using products through the harmonization of energy efficiency test and performance standards.

This chapter describes NRCan's intergovernmental cooperation efforts in EAE in 1996–1997.

FEDERAL–PROVINCIAL/ TERRITORIAL COOPERATION

Cooperation between NRCan and provincial and territorial governments took place at both the general level and at the level of program initiatives.

General Cooperation

Cooperation took place through three main mechanisms:

Letters of Cooperation (LOCs)

- Beginning in 1993, NRCan and departments responsible for EAE programs in six provinces (British Columbia, Saskatchewan, Manitoba, New Brunswick, Nova Scotia and Newfoundland) signed LOCs on EAE. The LOCs cover all forms of program initiatives and establish a management committee of representatives from NRCan and the relevant provincial department to administer the agreement. The management committee reviews policy and program developments, progress on joint program initiatives and possible areas for further cooperation in terms of EAE program delivery.
- The Canada–Manitoba LOC was signed on September 23, 1996, by the federal Minister of Natural Resources and the Manitoba Minister of Energy and Mines. The LOC facilitated the conclusion of an agreement between the two departments on the R-2000 HOME Program in the spring of 1997.
- Management committee meetings were held with British Columbia, Saskatchewan, Manitoba and New Brunswick.
- Reports on the Canada–Nova Scotia and the Canada–Newfoundland LOCs were provided to Ministers in September 1996. These reported on the joint activities conducted under the agreements during the previous 18 months.

Meetings with Other Energy Departments

- NRCan met with the Ontario Ministry of Environment and Energy in December 1996 to review EAE programs and potential areas of cooperation in industry, transportation and renewable energy.

Federal–Provincial Committees

- NRCan participated as a member of the Conservation and Renewable Energy Sub-Committee (CARES) of the Advisory Committee on Energy (a committee of federal, provincial and territorial deputy ministers of energy). This committee operated until September 1996, when its work was combined with that of the National Air Issues Coordinating Committee. CARES comprises officials dealing with EAE policies and programs in federal, provincial and territorial departments. CARES' main functions are to exchange information, cooperate on EAE programs and advise the Advisory Committee on Energy on EAE matters.

Cooperation at the Program Level

Directory of EAE Programs in Canada

- NRCan, provincial and territorial departments, provincial energy utilities and larger Canadian municipalities collaborated on the production by NRCan of the 1996 edition of the "Directory of Energy Efficiency and Alternative Energy Programs in Canada."

Model National Energy Codes for Buildings and Houses

- NRCan, provincial and territorial departments, and other parties continued to develop the Model National Energy Codes for Buildings and Houses. Most of the joint work proceeded through the Canadian Consortium for Building Energy Compliance Software. NRCan and the provincial departments of British Columbia, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia are members of the consortium.

The consortium provides a venue for governments and industry to collaborate on the development and support of commercial building energy simulation software. The software is designed to simplify the compliance and administration of the model National Energy Code for Buildings, make building simulation more accessible, improve general understanding of building energy performance and allow building owners to make more informed decisions regarding energy use and building costs.

R-2000 HOME Program

- The R-2000 HOME Program is delivered in all provinces except British Columbia and Prince Edward Island. In Saskatchewan, Manitoba, New Brunswick, Nova Scotia and Newfoundland, NRCan and the relevant provincial department support the program through a financial or in-kind contribution.

Energy Savings in Public Buildings

- In British Columbia, Alberta, Saskatchewan, Ontario, Quebec, New Brunswick and Nova Scotia, NRCan held a series of one-day information sessions on the Federal Buildings Initiative for managers responsible for the energy efficiency of government buildings.

The Enerhouse Conferences

- NRCan, the Nova Scotia Department of Natural Resources, Canada Mortgage and Housing Corporation, Nova Scotia Power, the Nova Scotia Home Builders' Association and the Atlantic New Home Warranty Corporation collaborated in the preparation of Enerhouse '96 and Enerhouse '97, annual housing conferences that focus on energy efficiency.

Equipment Energy Efficiency Regulations

- NRCan and five provinces (British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia) regulate the energy efficiency performance of prescribed equipment. They share information and consult through the Canadian Standards Association's Advisory Committee on Energy Efficiency.

Motor Vehicle Fuel Efficiency

- NRCan and six provincial governments collaborated through the Transportation Working Group of the National Air Issues Coordinating Committee.

Propane

- NRCan cooperated with British Columbia, Ontario, New Brunswick and Newfoundland in demonstration projects to develop propane facilities and markets in these provinces. In New Brunswick and Newfoundland, this cooperation was conducted under agreements linking NRCan, Superior Propane (the distributor) and the two provincial departments. The provinces reduced the road taxes on propane, while NRCan contributed communication, training and infrastructure development activities. These agreements ended on March 31, 1997.
- An agreement on the development and marketing by Chrysler Canada of a propane-fuelled van was signed by NRCan, the Government of Ontario, the Canadian propane industry and Chrysler Canada.
- NRCan worked with the British Columbia government and the propane industry to demonstrate the environmental performance of factory-built propane vehicles and factory-authorized conversions.

Renewable Energy

- NRCan consulted with provinces, industry and other parties on the development of a new Renewable Energy Strategy, which was released in November 1996.

FEDERAL–MUNICIPAL COOPERATION

- The Federation of Canadian Municipalities' 20% Club promotes municipal measures to reduce greenhouse gas emissions in Canada. NRCan provided information and advice to the club through participation in the club's Technical Advisory Committee.

- NRCan and the Municipality of Metropolitan Toronto cooperated in a demonstration project of factory-modified Ford pickup trucks fuelled by natural gas. Economic, technical and environmental data were collected to assess the performance of the vehicles.

INTERNATIONAL COOPERATION

International Energy Agency

Canada is a member of the International Energy Agency, an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD).

NRCan participates in a number of committees that review policies and undertake studies on energy efficiency and related issues. These committees include the Committee on Long-Term Co-operation (SLT) and the Energy Efficiency Working Party of the Standing Group on Long-Term Co-operation (EWP/SLT). The SLT develops policy analyses to promote conservation and the efficient use of energy while the EWP/SLT carries out more detailed studies on specific energy efficiency issues.

NRCan also works with the International Energy Agency's Secretariat to collect and analyze energy data, assess member countries' domestic energy policies and programs, and prepare studies and recommendations on specialized energy topics. At present, NRCan is working with the secretariat to develop consistent and comparable international indicators of energy efficiency and use.

As the operating agent responsible for the Small Hydro Task Force of the International Energy Agency Hydropower Implementing Agreement, NRCan developed an Internet small hydro database. The database distributes information on potential small hydro sites and market opportunities worldwide.

Asia-Pacific Economic Cooperation (APEC)

Since the first meeting of APEC Energy Ministers in Sydney, Australia, in August 1996, NRCan has played a leading role in efforts to ensure that energy efficiency standards do not become barriers to trade within the APEC region. Acting on Ministers' directions, NRCan chaired the APEC Steering Group on Energy Standards throughout 1996–1997. The steering group first met from March 20 to 22, 1997, in Vancouver, British Columbia.

The steering group is managing an assessment of options for a multilateral testing laboratory program so that suppliers can have their products performance-tested only once, at a regionally recognized laboratory. A project has also been launched to determine regional differences in test standards and establish a regional notification system on the use of standards. Finally, the steering group is exploring ways of having the standards needs of APEC economies more effectively communicated in international standards-making processes.

Hemispheric Energy Initiative

The Hemispheric Energy Initiative (HEI) is the energy component of the action plan developed after the Summit of the Americas in December 1994 and the Hemispheric Energy Symposium in October 1995. The aim of the HEI is to advance sustainable development and use of energy in the hemisphere. The HEI is composed of eight outcomes. One of them is the "Promotion of Energy Efficiency in the Hemisphere," which in turn comprises four initiatives:

- creation of a web site on energy efficiency;
- development of a hemispheric clean cities initiative;

- facilitation of financing of energy efficiency and renewable energy; and
- promotion of energy efficiency in equipment and buildings in the hemisphere.

Canada is leading the fourth initiative. In 1996–1997, NRCan's work concentrated on the design and organization of a Hemispheric Workshop on Energy Efficiency in Equipment and Buildings to be held in the summer of 1997. To this end, NRCan organized two main activities:

- NRCan organized and chaired a meeting in Ottawa in December 1996 of representatives of the Canadian International Development Agency, the World Bank, the Interamerican Development Bank, the United Nations Development Program and the U.S. Department of Energy. The purpose of the meeting was to share information on the activities of each organization related to energy efficiency in equipment and buildings, and to discuss the organization of the workshop in 1997.
- NRCan arranged conference calls in February and March 1997 with 10 countries of the Americas and three international organizations. The purpose of the calls was to obtain advice on the agenda for the workshop and the recruitment of participants.

United States

NRCan, the U.S. Department of Energy and the motor vehicle industry jointly sponsored the propane and future car student challenges. Teams of university students from Canada and the United States built propane-fuelled or hybrid electric vehicles, either from new designs or by converting production models, and entered them in the technical competition. These challenges generate valuable technical data and provide experience to new engineers.

Equipment Energy Efficiency Regulations and Labelling

NRCan collaborated with the U.S. Department of Energy and the U.S. Federal Trade Commission on energy efficiency regulations and labelling of equipment. Discussions took place on modifications to the regulation and harmonization of products, performance levels, testing methods and reporting between the two countries.

Motor Vehicle Fuel Efficiency

In March 1996, NRCan and the U.S. Department of Energy signed an MOU concerning road transportation, energy efficiency and alternative fuels. The MOU provides a formal mechanism for negotiating and harmonizing North American policy regarding fuel efficiency. Parties to the agreement have agreed to formalize contact as both nations consider options to respond to their respective climate change commitments. The two parties met twice in 1996–1997. One achievement was the design of an in-depth study to calculate the cost of new fuel economy technologies.

Mexico

In June 1996, NRCan and the Secretary of Energy of Mexico signed an MOU on EAE. The objective of the MOU is to contribute to the EAE efforts of both countries by

- achieving better mutual understanding of options for and experiences with EAE policies and programs;
- improving the design and delivery of EAE programs implemented or sponsored by the parties; and
- enhancing trade, investment, technical and other exchanges on energy efficiency products, energy management services and alternative energy goods and services.

The first management committee meeting under the MOU was held in Mexico City in November 1996. Representatives of NRCan, the Department of Foreign Affairs and International Trade, the Mexican Comisión Nacional Para el Ahorro de Energía (known as CONAE), and the Mexican Energy Secretariat attended the meeting. The delegations shared information on their respective EAE programs and explored possibilities for joint projects and programs.

China

Canadian Hydro Components and the Hangzhou Regional Centre in China signed a joint venture agreement on small hydro turbine control and protection systems. The agreement covers initial cooperation with the goal of adapting and transferring small hydro control and protection systems to the Chinese marketplace.

EAE Initiatives and Expenditures for 1996–1997

	($ Million)
General Programs	6.2
Consumer Information	
Community Energy Technologies Program	
National Energy Use Database	
Energy Efficiency—Buildings	11.3
Federal Buildings Initiative	
Model National Energy Codes for Buildings and Houses	
R-2000 HOME Program	
Home Energy Retrofit Initiative	
Energy Innovators Initiative	
Buildings Energy Technology Advancement Plans	
Federal Industrial Boiler Program	
Heat Management R&D (Buildings)	
Heating, Ventilation and Air Conditioning Energy Efficiency Rating Program	
Window Labelling Program	
Energy Efficiency—Equipment	2.9
Energy Efficiency Regulations	
EnerGuide Program	
Energy Efficiency—Industry	18.3
Advanced Combustion Program for Buildings	
Industrial Energy Efficiency Initiative	
Heat Management R&D Program (Industry)	
Industry Energy Research and Development Program	
Emerging Technologies Program	
Advanced Technologies for Process Optimization and Control Initiative	
Minerals and Metals Technologies Initiative	
Energy Efficiency—Transportation	2.4
Motor Vehicle Fuel Efficiency Program	
Auto$mart	
FleetWise	
FleetSmart	
Alternative Energy—Alternative Transportation Fuels	10.3
Alternative Transportation Fuels Market Development Initiative	
Alternative Transportation Fuels R&D Program	
Alternative Energy—Renewable Energy Sources	10.0
Energy from the Forest Program	
Renewable Energy Technologies Program	
Renewable Energy Market Assessment Program	
Renewable Energy Information and Awareness Program	
Green Power Initiative	
TOTAL	61.4

Data Presented in the Report

Figure 2
Number of Regulated Energy-Using Products Imported into Canada in 1996-1997

Apr 1996	May 1996	Jun 1996	Jul 1996	Aug 1996	Sep 1996	Oct 1996	Nov 1996	Dec 1996	Jan 1997	Feb 1997	Mar 1997
1,545,072	1,838,975	1,448,337	1,695,911	1,027,124	1,222,874	441,589	2,938,316	1,354,005	2,049,073	1,683,353	1,947,367

Figure 5
Change in Secondary Energy Use, With and Without Energy Intensity Improvements, 1990 to 1996 (Petajoules)

	1990	1991	1992	1993	1994	1995	1996
With Intensity Improvements	0.00	-112.40	-49.69	160.64	365.88	567.49	781.83
Without Intensity Improvements	0.00	-132.24	61.54	356.60	616.41	810.27	1028.47

Figure 6
Households by Type of Dwelling, 1996 (Percent)

	1996
Single Detached	55.27
Apartments	32.34
Single Attached	10.50
Mobile Homes	1.89

Figure 7
Residential Energy Use, 1990 and 1996 (Percent)

	1990	1996
Space Heating	61.4	61.0
Water Heating	19.9	21.3
Appliances	14.1	13.2
Lighting	4.1	4.1
Space Cooling	0.4	0.4

Figure 8
Aggregate and Weather/Structure-adjusted Energy Intensity from 1990 to 1996 (Index: 1990 = 1.00)

	1990	1991	1992	1993	1994	1995	1996
Weather/Structure-adjusted Energy Intensity	1.00	0.9402	0.9192	0.9300	0.9400	0.9021	0.9370
Aggregate Energy Intensity	1.00	0.9463	0.9575	0.9798	0.9770	0.9376	0.9977

Figure 9
Average Annual Heating Cost for Houses Constructed to Different Standards (Dollars per Year)

Typical Existing House	550
Typical New House	275
Model National Energy Code House	192
R-2000 House	106
Advanced House	53

Figure 10
R-2000 Share of National, Nova Scotia and New Brunswick Housing Completions, 1983 to 1996

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
New Brunswick	0.03	0.00	0.55	0.53	1.16	1.83	1.87	0.61	1.47	8.45	9.98	9.81	12.85	3.65
Nova Scotia	0.00	0.00	0.11	0.04	0.12	0.54	1.27	2.43	1.54	0.80	1.24	1.38	4.03	4.08
Canada	0.04	0.00	0.14	0.18	0.33	0.28	0.52	0.35	0.49	0.90	1.24	0.64	0.67	0.44

Figure 11
National Trends in Air Leakage in Houses by Period of Construction, 1981 to 1995 (Air Changes per House per Hour)

	1981–1985	1986–1990	1991–1995	R-2000 Home Program Standard 1981–1995
National	5.38	3.67	3.05	1.5

Figure 12
Share of Residential Energy Consumption Subject to the *Energy Efficiency Regulations*, 1996 (Petajoules)

	Regulated	Unregulated
Total	941	512
HVAC	514	380
Water Heating	306	2
Appliances and Lighting	121	130

Figure 13
Average Energy Consumption of New Appliances, 1990 and 1996 (kWh per Year)

	1990	1996
Clothes Washers	1,150.00	912.50
Clothes Dryers	1,095.00	894.00
Refrigerators	1,018.00	656.00
Dishwashers	1,000.00	601.63
Ranges	738.00	772.00
Freezers	530.00	364.00

Figure 14
Distribution of Refrigerator Sales According to Energy Consumption, 1990 and 1996 (Percent)

kWh per Year per Cubic Foot	20	30	40	50	60	70	80	90	100	110	120	130
1990	0.00	1.36	3.51	13.29	63.62	14.65	3.47	0.00	0.07	0.00	0.00	0.04
1996	7.96	55.85	35.48	0.17	0.00	0.00	0.52	0.00	0.01	0.00	0.00	0.00

Figure 15
Size and Energy Consumption of New Refrigerators, 1990 and 1996

	1990	1996
Size (Adjusted Volume)	17.68	18.92
Energy Consumption (kWh)	939.00	617.89

Figure 16
Natural Gas Furnace Sales by Efficiency Level, 1990 and 1996 (Thousands of Units)

	1990	1996
Normal Efficiency	87.25	0.00
Mid-Efficiency	22.04	90.09
High-Efficiency	29.92	69.50

Figure 17
Energy Use Trends for Refrigerators, 1991 and 1997 (kWh per Year)

Source: Natural Resources Canada EnerGuide database.

Figure 18
Commercial and Institutional Energy Use by Building Type, 1996 (Petajoules)

Retail	235.91
Office	237.68
School	137.67
Health	109.84
Hotel/Restaurant	105.45
Other	167.02

Figure 19
Commercial and Institutional Energy Demand by End Use, 1996 (Percent)

Lighting	13.91
Space Cooling	4.38
Auxiliary Motor	11.88
Auxiliary Equipment	9.71
Space Heating	53.57
Water Heating	6.56

Figure 20
Commercial and Institutional Energy Intensity and Floor Space, 1990 to 1996 (Index: 1990 = 1.00)

	1990	1991	1992	1993	1994	1995	1996
Floor Space	1.00	1.0312	1.0542	1.0710	1.0821	1.0930	1.1098
Weather-adjusted Energy Intensity	1.00	0.9660	0.9703	0.9564	0.9470	0.9643	0.9594

Figure 21
Energy Use in Commercial Buildings, 1996 (Megajoules per square metre per year)

Current Practice	1 300
Model National Energy Code	1 105
C-2000 Demonstration Projects	553

Figure 22
Annual Energy Use Before and After FBI Retrofits (Megajoules)

	Before	After
Harrow	12 896	8 402
Valcartier	168 000	134 000
CCIW	58 996	48 300
CRC	97 806	75 508
R.H. Coats	56 931	38 931

Figure 23
Annual Recruitment of Commercial/Institutional Energy Innovators, 1992–1993 to 1996–1997

	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997
Recruitment (Organizations)	47	82	75	104	45

Figure 24
Number of Projects and Action Plans, 1992–1993 to 1996–1997

	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997
Number of Projects and Action Plans	15	26	24	33	14

Figure 25
ESCo Activity and Contract Values, 1991 to 1995

	1991	1992	1993	1994	1995
Total Contract Value ($ Millions)	40.98	61.76	128.47	186.54	278.01
Projects	39	53	76	123	209

Figure 26
Average ESCo Project Size and Energy Savings, 1991 to 1995 (Thousands of Dollars)

	1991	1992	1993	1994	1995
Average Project Size	1,050.88	1,165.35	1,690.39	1,516.61	1,330.18
Average Annual Savings	138.55	163.59	183.90	183.92	154.81

Figure 27
Annual Energy Savings from FIBP, 1991–1992 to 1996–1997 (Terajoules per Year)

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997
Energy Savings	20	50	40	70	90	80

Figure 28
Influence of Lighting Regulations on the Energy Use of Two Fluorescent Lamp Types, 1996 (Watt Rating)

	Before Regulation	After Regulation
4-foot, medium bi-pin	40	34
8-foot, high-output	75	66

Figure 29
Annual Sales of Common Fluorescent Lamps, 1996 (Units Sold)

4-foot, medium bi-pin	21 780 512
8-foot, high-output	2 800 136

Figure 30
Distribution of Energy Use and Activity by Industrial Subsector, 1996 (Percent)

	Energy Use	Activity
Pulp and Paper	29.1	5.8
Mining	13.4	15.5
Petroleum Refining	10.9	1.4
Iron and Steel	8.5	1.8
Chemicals	7.8	1.8
Smelting and Refining	7.9	1.9
Cement	1.9	0.3
Construction	1.6	16.9
Forestry	0.3	1.9
Other Manufacturing	18.7	52.7

Figure 31
Cost of Energy Used by Industry as a Percentage of Total Production Cost, 1996 (Percent)

Cement	37
Smelting and Refining	18
Chemicals	15
Pulp and Paper	9
Iron and Steel	8
Petroleum Refining	2

Figure 32
Industrial Energy Use and Intensity, 1990 to 1996 (Index: 1990=1.00)

	1990	1991	1992	1993	1994	1995	1996
Energy Intensity	1.00	1.06	1.05	1.05	1.02	1.06	1.05
Structure-adjusted Intensity	1.00	1.07	1.02	0.99	0.98	1.02	1.03
Energy Use	1.00	0.99	0.98	1.02	1.05	1.11	1.12

Figure 33
Industrial Energy Intensity by Industry, 1990 and 1996 (Gigajoules per GDP in 1986 Constant Dollars)

	Aggregate Intensity	
	1990	1996
Petroleum Refining	0.156	0.141
Cement	0.130	0.135
Iron and Steel	0.090	0.085
Pulp and Paper	0.085	0.092
Smelting and Refining	0.082	0.074
Chemicals	0.072	0.082
Mining	0.013	0.016
Other Manufacturing	0.008	0.007
Forestry	0.005	0.003
Construction	0.001	0.002

Figure 34
Average Annual Intensity Change, 1990 to 1996 (Percent)

Physical Denominators	
Aluminum	-1.6
Brewery	-2.4
Cement	-1.6
Chemicals	-1.6
Dairy	-0.5
Lime	-1.6
Mining	0.5
Petroleum Refining	-0.7
Pulp and Paper	-0.6
Steel	-0.9
Monetary Denominators	
Electrical/Electronics	-10.6
Rubber	-1.9
Transportation	0.3
Wood Products	4.0

Figure 35
Recruitment of Industrial Energy Innovators and Action Plans, 1996 and 1997

	March 1996	March 1997
Innovators (Organizations)	212	238
Number of Action Plans	18	172

Figure 36
Energy Efficiency Standards Before and After Motor Regulations (Percent Efficiency)

	Existing Efficiency Standards			New Efficiency Levels		
Motor Size (hp)	3600 r/min	1800 r/min	1200 r/min	3600 r/min	1800 r/min	1200 r/min
1.0	74.0	75.0	75.0	75.5	82.5	80.0
1.5	76.5	77.0	77.0	82.5	84.0	85.5
2.0	78.6	79.0	79.0	84.0	84.0	86.5
3.0	80.5	81.0	80.9	85.5	87.5	87.5
5.0	82.0	82.5	82.5	87.5	87.5	87.5
7.5	83.3	84.6	84.0	88.5	89.5	89.5
10.0	84.5	86.0	85.2	89.5	89.5	89.5
15.0	85.5	87.4	86.3	90.2	91.0	90.2
20.0	86.5	88.3	87.2	90.2	91.0	90.2
25.0	87.4	89.0	88.0	91.0	92.4	91.7
30.0	88.0	89.5	88.6	91.0	92.4	91.7
40.0	88.5	90.0	89.2	91.7	93.0	93.0
50.0	89.0	90.5	89.6	92.4	93.0	93.0
60.0	89.4	90.9	90.1	93.0	93.6	93.6
75.0	89.7	91.2	90.5	93.0	94.1	93.6
100.0	90.0	91.6	90.9	93.6	94.5	94.1
125.0	90.4	91.8	91.3	94.5	94.5	94.1
150.0	90.6	91.9	91.6	94.5	95.0	95.0
200.0	90.8	92 0	92.0	95.0	95.0	95.0

Figure 37
Energy Savings from Motor Regulations, 2000 to 2020 (Petajoules per Year)

	2000	2005	2010	2020
Commercial Energy Savings	2.1	4.6	6.8	6.7
Industrial Energy Savings	2.2	5.9	9.5	11.0
Total Energy Savings	4.3	10.5	16.3	17.7

Figure 38
Energy Use by Transportation Mode, 1996 (Percent)

Passenger–Light Vehicles	78.50
Passenger–Aviation	16.37
Passenger–Buses	4.95
Passenger–Rail	0.18
Freight–Trucks	74.50
Freight–Marine	14.47
Freight–Rail	11.03

Figure 39
Passenger Vehicle Energy Use and Intensity, 1990 to 1996 (Index: 1990 = 1.00)

	1990	1991	1992	1993	1994	1995	1996
Passenger-kilometre	1.00	0.96	0.99	1.01	1.05	1.07	1.10
Energy Use	1.00	0.97	0.96	0.95	0.94	0.94	0.94
Energy Intensity	1.00	0.99	1.03	1.07	1.12	1.15	1.18

Figure 40
New Passenger Car and Light Truck Market Shares, 1990 to 1996 (Percent)

Model Year	1990	1991	1992	1993	1994	1995	1996
New Car Sales	68.73	68.95	66.32	63.98	61.63	59.92	56.89
New Light Truck Sales	31.27	31.05	33.68	36.02	38.37	40.08	43.11

Figure 41
Fuel Economy of New Cars, Normalized for Size and Power, 1990 to 1995 (Index: 1990 = 1.00)

	1990	1991	1992	1993	1994	1995
L/100 km/tonne	1.00	0.991	0.965	0.973	0.920	0.892
L/100 km/hp	1.00	1.005	0.954	0.953	0.913	0.903
L/100 km	1.00	0.994	0.963	0.976	0.962	0.959

Figure 42
Energy Intensity of the Federal Vehicle Fleet, 1990 and1996 (L/100 km in Terms of Gasoline Equivalent)

1990	1996
19.85	18.67

Figure 43
Natural Gas and Propane Vehicle Conversions, 1990 to 1996

	1990	1991	1992	1993	1994	1995	1996
Natural Gas	3 122	5 147	2 781	2 294	2 076	2 304	1 009
Propane	23 000	24 000	16 000	13 000	15 000	10 000	6 500

Figure 44
Number of Fuelling Stations Selling Ethanol-blended Fuels, 1990 to 1997

	1990	1991	1992	1993	1994	1995	1996	1997
Number of Stations	266	270	300	336	560	640	691	697

Figure 45
Use of Alternative Transportation Fuels, 1990 to 1996

	1990	1991	1992	1993	1994	1995	1996
Propane	25.94	28.90	29.19	32.40	33.87	37.47	34.80
Natural Gas	3.42	2.71	2.87	3.00	5.26	7.78	7.80
Alcohols	0.91	1.09	1.26	1.44	1.56	1.56	1.56

Figure 46
Cumulative Installed Wind-power Capacity, 1990 to 1997

	1990	1991	1992	1993	1994	1995	1996	1997
Cumulative Megawatts	4.5	4.5	4.5	0.5	21.0	21.6	21.8	25.3

Figure 47
Carbon Dioxide Reductions from Community Energy Projects (Kilotonnes per Year)

Oujé-Bougoumou	2.8
Cornwall	7.8
Grassy Narrows	9.0
Windsor 1	13.0